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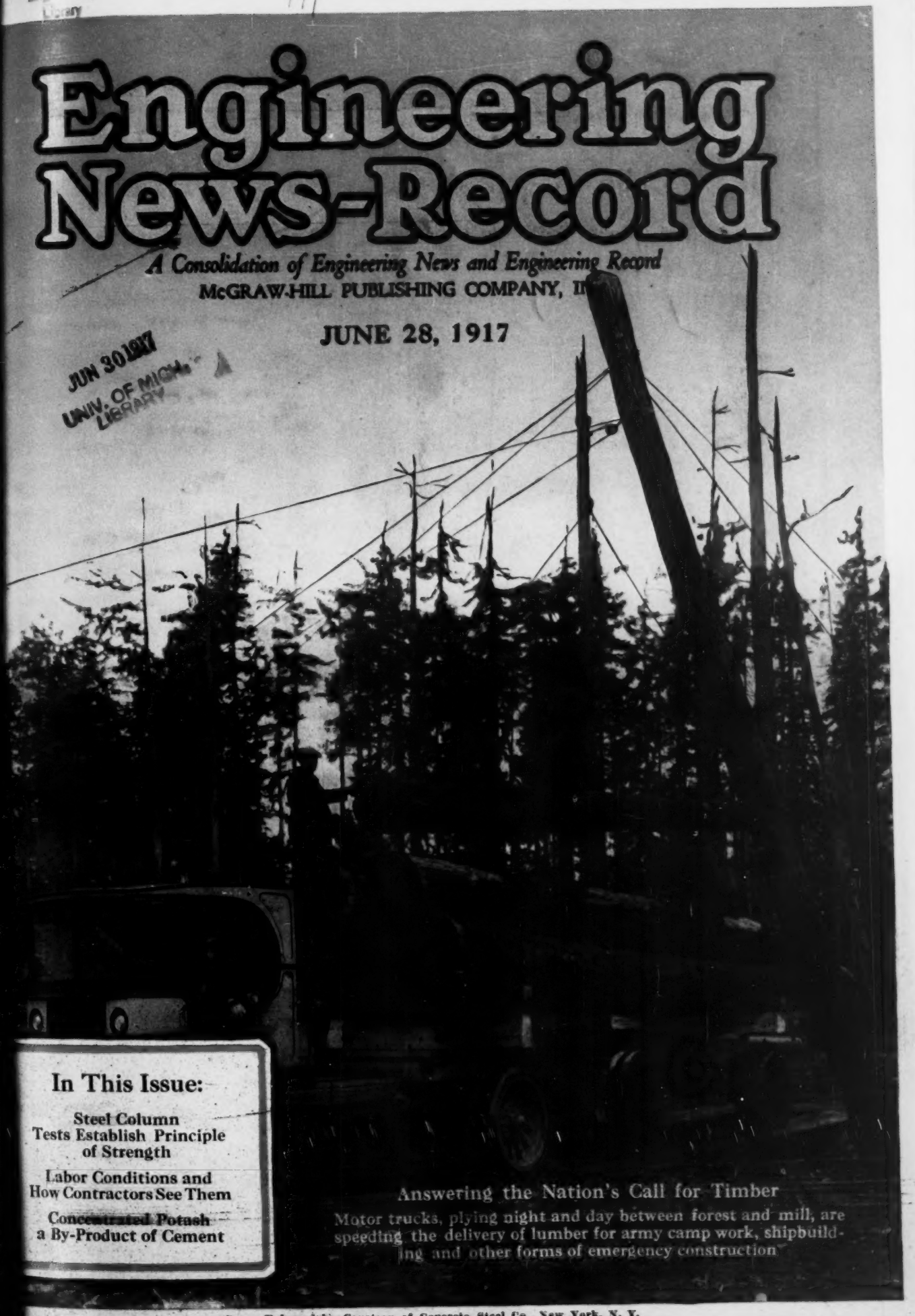

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Steel Column Tests Establish Principle of Strength

Labor Conditions and How Contractors See Them

Concentrated Potash a By-Product of Cement

Answering the Nation's Call for Timber

Motor trucks, plying night and day between forest and mill, are speeding the delivery of lumber for army camp work, shipbuilding and other forms of emergency construction

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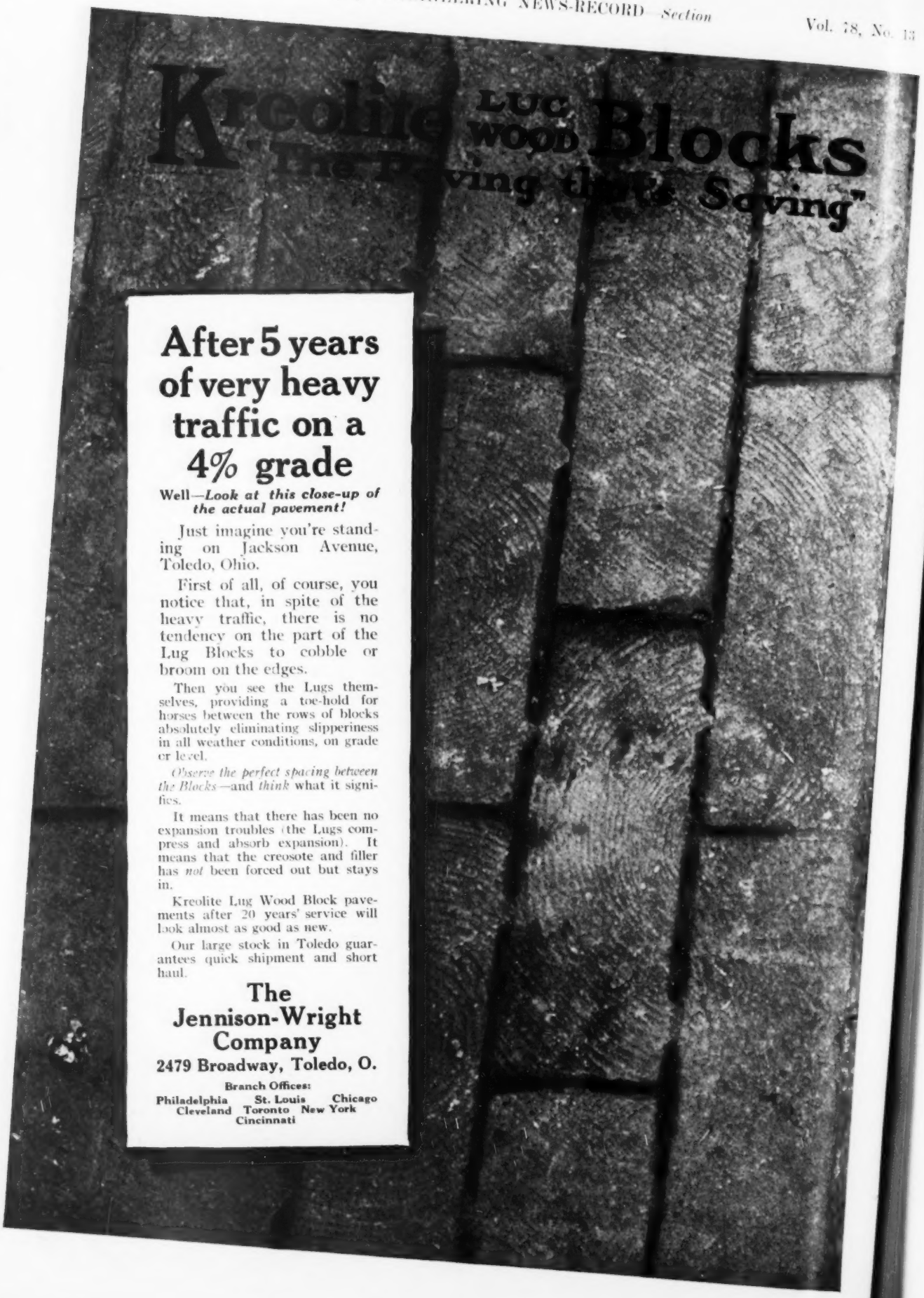

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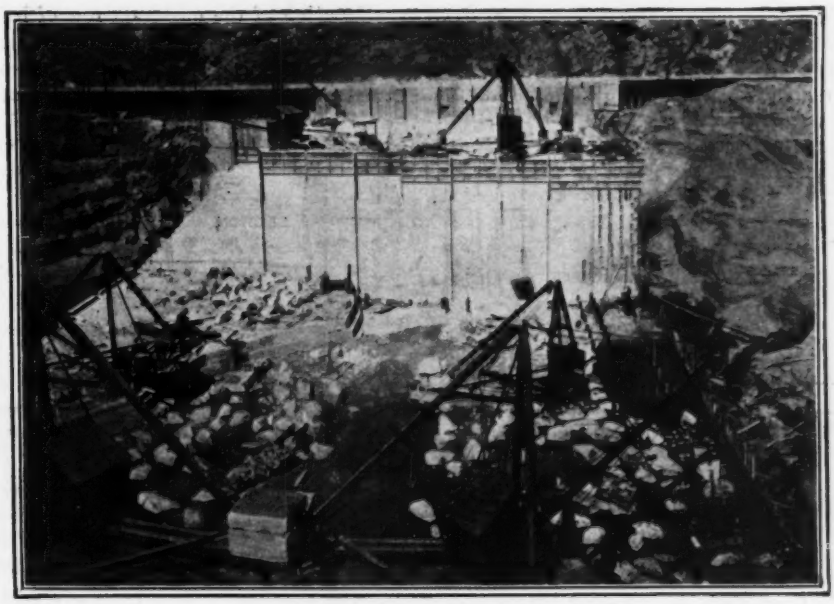
Grouting the Foundation of the Elephant Butte Dam

Upstream Row of Grouted Holes and Two Downstream Rows of Drainage Wells Serve as Telltales



By E. H. BALDWIN
Formerly Senior Engineer, United States Reclamation Service

THE foundation of the Elephant Butte Dam of the United States Reclamation Service was in rock strata of such a nature that precautions against subpercolation were thought necessary. These precautions took the form of a line of drill holes in the lowest part of the cutoff wall, which were grouted tight, and two rows of drainage wells, both upstream of the grout barrier. These drainage wells were used as detectors of percolation and, where such percolation was found, as grout holes to fill up the fissures through which the water percolated.

Excavation for the foundation was carried to a maximum depth of 100 ft. below the old river bed. The material excavated was gravel, sandstone and shale. The sandstone was in layers, separated by shale, which when first uncovered was quite hard, but quickly disintegrated on exposure to the air. The sandstone was badly fissured, in fairly uniform layers in the bottom, but at the abutments was irregular and in places showed distinct folds. When the foundation was cleaned and prepared, and before masonry was started, a number of test holes were put down with a churn drill to a depth of 20 ft. or more to make sure that a satisfactory foundation had been reached.

A typical cross-section of the dam shows the cutoff trench, grouting holes and drainage wells and their relation to the drainage gallery. By means of iron pipe, carefully set and left in place, 4-in. holes were carried up from the center of the cutoff trench, spaced 10 ft. apart, parallel to the axis of the dam, to a height of about 20 ft.; above this they were formed in concrete with collapsible metal forms 6 in. in diameter; these holes were later drilled into the rock to a depth of 45 ft. and grouted with cement under high pressure.

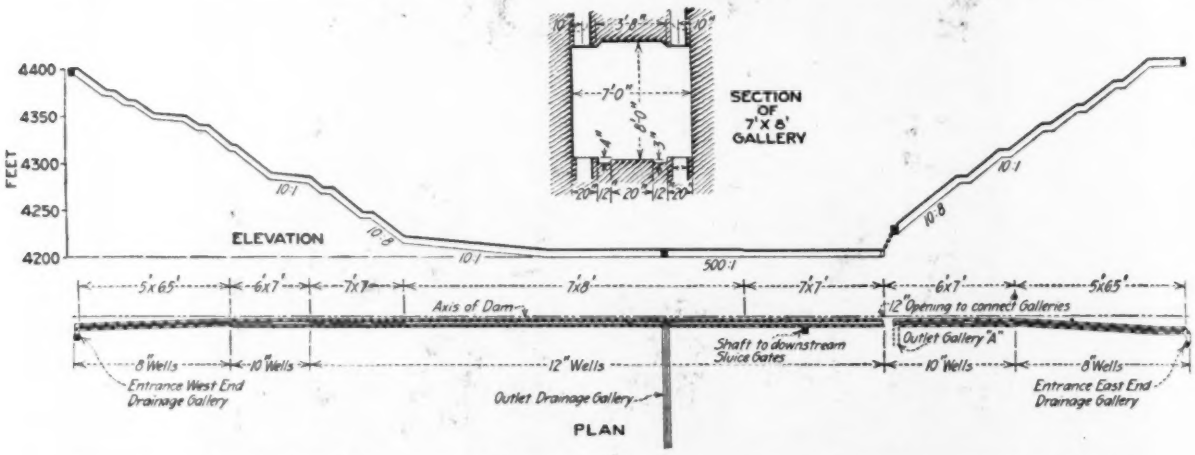
About 10 ft. downstream from the line of grouting holes, a series of drainage wells were formed in the concrete, spaced 8 ft. apart and starting at bedrock. A similar row of drainage wells was formed 5 ft. downstream from the upper row and staggered with reference to them. The wells vary in size from 12 in. through the central portion of the dam to 8 in. near the upper portion of the abutments, as indicated in the plan. They were carried up to an inspection gallery, which also serves as a drainage gallery, with an outlet leading to the down-

stream face of the dam and discharging a few feet above river level. From the roof of the inspection gallery these wells were continued to the top of the dam and capped with a concrete plug 10 in. thick.

The upstream row of drainage wells was drilled with a 6-in. well drill to a depth of 45 ft. below the base of the dam, to intercept and discharge into the drainage gallery any waters that might develop sufficient head to rise to that elevation. It was also planned to grout any of the wells that showed undue leakage. The downstream row was drilled to a depth of 5 ft. only.

Grouting Holes Made with Core Drills

The placing of masonry in the dam commenced in June, 1913, and in December of that year drilling of the grouting holes was started with a Davis-Calyx core drill. A Davis cutter was at first used; but on account of the hardness of the sandstone encountered, the cutter was soon changed for a shot bit, which gave excellent results.



WHERE THE GROUTING HOLES AND DRAINAGE WELLS ON ELEPHANT BUTTE DAM WERE LOCATED

This drilled a hole 2⅝ in. in diameter with a resultant core of 1⅝ in. This drill was operated almost continuously until January, 1915, during which time 2993 lin.ft. was drilled, 1625 ft. of core recovered. Actual time in operation, 3968 hours; actual drilling time, 2913 hours.

The quarry drilling was done with two 6-in. well drills; and when one of these could be dispensed with (March, 1914), it was moved to the dam and started drilling the upper row of drainage wells. As the cost of drilling with these machines was much less than with the core drill and as it was not essential that cores be recovered, when the second well drill was available (January, 1915) it was rigged with a 3-in. bit and used for drilling the remainder of the grouting holes. The two well drills drilled a total depth of 28,308 ft. Comparative unit costs of the core drills and the well drills are shown in the accompanying table.

Item of Drilling	Unit Costs Core Drill	Well Drill
Operation of drill, labor and supplies	$1.120	$0.372
Repairs: labor and supplies, including shop work	.330	.218
Rigging and moving, labor and supplies	.088	.018
Depreciation	.300	.076
Overhead expense	.127	.081
Total, per linear foot	$1.965	$0.765

In connection with the drilling costs it is only fair to state that the placing of masonry was crowded to the utmost and given the preference over other work, for which reason the drills were often operated at a disadvantage. Much of the drilling, particularly the drainage wells, was done when the dam had attained considerable height; and as the drums on the well rigs were not large enough to accommodate more than 300 ft. of rope, it was necessary to substitute ⅝-in. wire rope for holes in excess of 300 ft. deep. Stretching of the manila rope was another reason for substituting the wire rope. Holes full of wood, others with crushed metal casings and still others with chains, hammers, etc., that had dropped from above and became embedded in the concrete were a source of much delay and the cause of many broken and lost tools.

How the Upstream Holes Were Grouted

Grouting of the upstream row of holes was commenced Feb. 9, 1914. The work was done with a Canniff grouting machine that had previously seen service at the Estacada dam and later at the Lahontan dam. Compressed air was piped to the dam from the central compressing plant, delivered there at a pressure of 100 lb. per sq.in., but due to varying uses at other points and to some leakage, it was rarely over 85 lb. at the machine. Water under pressure of 100 to 135 lb. was piped to the dam from the storage tank. The grouting machine was supplied from air and water mains through ¾-in. hose and pipe lines. Cement, supplies and equipment were stored in skips and moved by cableways or derricks as required.

After the grouting holes were drilled, they were cleaned with a water jet, which was conducted to the bottom through a hose, the pressure washing loose particles to the top and cleaning out seams and fissures. A 4- or 5-ft. length of pipe, of 2- or 3-in. diameter, with one end threaded to attach the machine coupling and the other end burred or threaded to retain a washer a little smaller than the diameter of the hole, was then set in the hole. Above the washer, cotton waste or rope ravelings were wrapped and tamped to a close fit around the sides of the hole; the pipe was temporarily held in place by a collar clamped around it about 8 in. below the projecting end. Cement grout was then poured around the pipe and allowed to set, and the pipe was kept capped until ready for grouting.

In addition to the regular line of grouting holes in the cutoff trench, many scattering holes were grouted. Throughout the body of the dam, wherever fissures in bedrock were found, 2-in. pipe was set in them; and after a mat of concrete of sufficient thickness to withstand the pressure had been placed around them, generally 4 to 10 ft., the fissures were grouted. There was naturally no regular system in the placing of these pipes; groups of fissures were usually found to be connected and often when one was being grouted the grout would flow from other pipes in the group.

Two Men Made Up Grouting Crew

A crew of two men handled the grouting except when an open hole taking large quantities of grout freely was encountered and speed in charging and handling cement became essential, or for passing cement when the outfit was located in a place inaccessible to derrick or cableway; then the force was temporarily increased accordingly. Ordinarily, one shift of 8 hours was sufficient to complete the grouting of one hole, but at times two or three succeeding shifts were worked. Operation was made as nearly continuous as possible; for when the grouting of a hole was commenced, it was found desirable, if not imperative, to complete it before stopping.

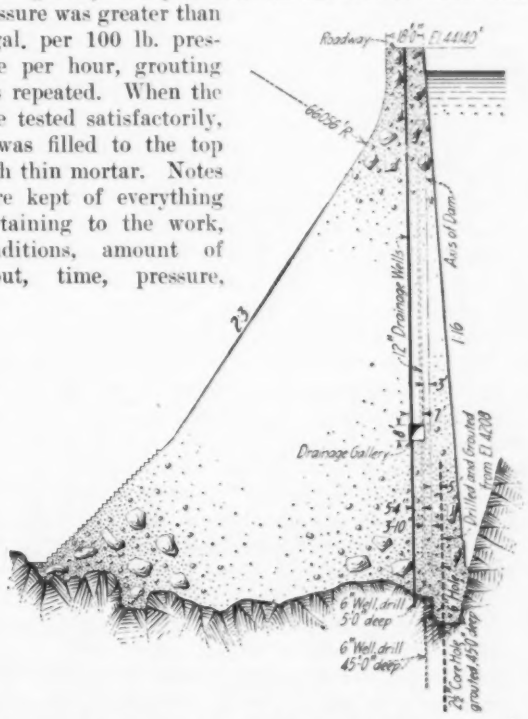
It was not practicable to adhere to any set rule for grouting, as the character of the holes was too variable and much had to be left to the judgment of the operator; but procedure was about as follows: After the hole was clean and empty of water (in tight holes water was expelled by compressed air), grouting was begun. Three proportions of grout were used: 1 part by volume of cement to 7 parts by volume of water; 2 parts of cement to 7 parts of water; and 3 parts of cement to 7 parts of water. These were referred to as 1:7, 2:7 and 3:7 charges. Both portland and sand cement were used—portland cement in tight and moderately tight holes, and sand cement where large fissures were to be filled. Sand cement was used wherever possible, as it apparently set as well as portland, mixed and handled better in the machine and was less liable to collect and choke, either in the machine or in the hole before the fissures were all filled.

The first charges were always of the 1:7 mix and usually began with a gravity head alone, continuing until the flow slackened to 1 gal. per min., when air pressures of 20 to 25 lb. were applied. These pressures continued until the flow again slackened, when pressures were gradually increased to the total amount available, when this could safely be used. It was noted that, when no external pressure existed, thin mixtures under low initial pressures had the greater radius of penetration.

Holes Were Tested for Tightness

Grouting was continued until no more grout would enter, or in connected fissure pipes until grout issued from adjacent pipes or openings in the rock beyond the concrete. Whenever possible, the operation was repeated after an interval of several days to insure a thorough filling of voids left by the excess water in the grout. While grouting, a continued lookout was maintained for grout, or air and water, coming out of surface openings near-by, and other evidences of its penetration. Holes in sandstone were usually easily grouted, for fissures in this class of rock were as a rule clean cut and well defined; on the other hand, holes in shale seldom took much grout, and seams and fissures were difficult to keep open until grouted.

After grouting, the holes were tested by filling them to the top with water and measuring the loss per hour, both under gravity and pressure. If the loss of water under pressure was greater than 3 gal. per 100 lb. pressure per hour, grouting was repeated. When the hole tested satisfactorily, it was filled to the top with thin mortar. Notes were kept of everything pertaining to the work, conditions, amount of grout, time, pressure,



SECTION SHOWS LOCATION OF TELLTALE WELLS AND GROUT HOLE

tests, material and labor. Cement was reported in units of sacks, water in gallons and air in cubic feet of free air.

Grouting was completed in August, 1916. A total of 267 holes was grouted, using 3029 sacks of portland cement and 6547 sacks of sand cement. Of these, 137 were drilled holes and 109 were fissures grouted through pipes. The maximum amount of cement in any one hole was 649 sacks, which was forced into a fissure.

Some Drainage Holes Show Seepage

The upstream row of drainage wells, as stated in a preceding paragraph, is 10 ft. downstream from the line of grouting holes, spaced 8 ft. apart and drilled 45 ft. into the rock below the base of the dam. The second row of drainage wells is about 5 ft. downstream from the first row, staggered with reference to them, but drilled only 5 ft. into the rock. In discussing the seepage, or flow, from these wells they will be referred to as U.S. and D.S., meaning upstream and downstream rows respectively.

The appearance of water flowing from the drainage wells was not unexpected. The first seepage detected was in March, 1915, from well No. 56 U.S. As soon as a well commenced discharging, it was plugged with a wooden stopper, in the center of which was screwed a piece of 1¼-in. pipe, projecting vertically about 2 ft. above the hole, the upper end being fitted with a 90° elbow and a short

piece of 1½-in. pipe. The stopper was set about 6 in. into the well and covered with cement mortar to the level of the floor. This confined the flow to a small stream that was readily measured. As the depth of water in the reservoir increased, other wells commenced discharging and were similarly treated.

The flow from Nos. 59 and 60 U.S. increased considerably after the drill hole below it was sunk, indicating that the drill had penetrated a rock seam connected with the reservoir. The record of No. 59 U.S. will be given in considerable detail, to show how the flow was finally stopped, or decreased to a negligible quantity, as this is typical of all holes similarly treated. Seepage was first noticed Apr. 26, 1916, and the well plugged the following day. Drilling operations disclosed the fact that Nos. 59 and 60 U.S. were connected. Prior to the drilling of No. 59 the flow in this vicinity was entirely from No. 60. This condition, however, was reversed after No. 59 was drilled. On Apr. 28 the flow from No. 59 was 22 gal. per min.; May 13, it was 27 gal.; May 19, it was 33 gal.; May 20, it was 56 gal.; May 24, it was 84 gal.; and on May 25, it was 85 gal., the maximum reached. At no time was there evidence of erosion; but to forestall any such action, it was decided to grout the hole. This was successfully accomplished on June 1, by forcing 121 sacks of portland cement and 29 sacks of sand cement into the well; all charges except the last were placed under gravity, the last charge being forced in under 110 lb. pressure. In August this hole was redrilled to its original depth, and a flow of 13 gal. per min. resulted. It was again grouted Sept. 10, when 46 sacks of cement were used. It was redrilled Sept. 28, the resulting flow being only 1.35 gal. per min. On Mar. 1, 1917, under about the same head, the flow was only 0.64 gal. per minute.

Few Drainage Wells Needed Grouting

Whenever a drainage well showed excessive seepage, grouting was resorted to, the result being that the total seepage, including percolation through the abutments, which were composed of very seamy rock, but thoroughly grouted, was reduced from a maximum of 120.3 gal. per min. to the present flow of 57.7 gal. per min., the height of water in the reservoir being practically the same. In every case the holes were redrilled after grouting. The maximum flow of 120.3 gal. from 230 drainage wells and both abutments, with a head of 125 ft. on 115 of the wells, is considered a remarkably good showing when the character of the foundation is known.

The drilling was done under the direct supervision of R. J. Schmalhausen, superintendent of construction. The bulk of the grouting was done by Victor Lieb, under the immediate direction of L. J. Charles, engineer, and later H. S. Stanton, assistant engineer. The entire work was done under the general supervision of the writer.

Tennessee To Build 2000 Miles of Roads

More than 2000 miles of new roads will be built in Tennessee during this spring and summer. Bonds have already been voted for this purpose and many counties have already sold the issues. Nine counties in East Tennessee are now advertising bond issues for sale, and the proceeds of which will be used on roads.

Milwaukee Air-Diffusion Studies in Activated Sludge

Problem Analyzed—Must Expose Large Air-Water Interface—Nozzles and Mechanical Beaters Eliminated—Fine-bubble Diffuser Plates Most Promising

By CARL H. NORDELL
Engineer of Designs, Milwaukee Sewerage Commission

THE article on "Air Diffusion in Activated Sludge," contributed by W. S. Coulter in *Engineering News-Record* of May 3, 1917, prompts the present writer to submit some of his own observations and experiments in the same field.

First, however, it is gratifying to learn that Mr. Coulter appreciates oxygenation of the water as the all-important point. There has in the past been altogether too much emphasis placed upon the agitation produced by the compressed air. The writer believes that the agitation in itself plays no useful part in the process except that of maintaining the sludge in suspension; and that it is a positive drawback when it becomes at all violent.

Mr. Coulter quotes Rideal as stating that ½ gal. of air is sufficient to oxidize completely the nitrogenous matter in 1 gal. of English sewage. When using 2 cu.ft. to the gallon, therefore, only some 3⅓% of the air would be utilized even for complete nitrification. This comparison, however, is not quite to the point and places the efficiency too high. The process can proceed without nitrification and would seem to be more nearly dependent upon the oxidation of the carbonaceous matter. No exact information as to the actual amount of oxygen required has been obtained, so far as the writer is aware. Some of the writer's research experiments, too tedious for detailed statement here, indicate that the treatment of Milwaukee sewage requires about 100 p. p. m. of oxygen. This would account for only about 1¼% of the oxygen in the air, as used at present. At any rate, there can be no question that the present methods of air application are extremely inefficient.

Increasing Air-Diffuser Efficiency

The problem of increasing this efficiency is stated by Mr. Coulter to be one of prolonging the contact of the air with the water. This is true if the qualifying phrase "without additional expenditure of energy" is added. One method of prolonging the contact is by using deeper tanks; but as the pressure of the air must be correspondingly increased, no very great gain is realized. Mr. Coulter proposes to prolong the contact by carrying the air downward through the water before permitting it to rise and, by means of his cone deflector, more or less "anchor" the bubbles, as it were, in descending streams of water. It would seem, however, that there is nothing to be gained by this procedure, for the energy expended in moving water against the bubble is exactly equal to that expended by a bubble moving against the water, and it is immaterial whether the energy is administered in the form of moving water or a constantly renewed stream of moving bubbles.

As for the jet-and-drive-pipe device, that is essentially a hydraulic compressor and possesses no advantage over

a mechanical compressor. Practically the same amount of energy must be supplied in either case. The jet and drive pipe, moreover, labors under a severe practical handicap. Mr. Coulter states that the drive pipe delivered air in the ratio of a volume of air to a volume of jet water at a depth approximating 70 to 80% of the kinetic head of the jet. These figures are not to be doubted, as they correspond well with the known efficiency of hydraulic compressors; but when we come to consider that the entire aërating mix would have to be sent through the jets 15 times for sufficient aëration, the difficulties are obvious.

Exposing Large Air-Water Interface

Mr. Coulter is on sure ground when he speaks of prolonging contact by subdividing the air into small enough bubbles so that their speed of ascent is lessened. The whole problem is one of exposing as large an air-water interface as possible in a given tank with a given rate of air feed. The more slowly the air escapes from the water the more of it will be in transit at any one time, and the finer the subdivision the more surface will this volume in transit expose. The total air-water interface for any given conditions of air feed and tank depth will vary inversely with the speed of the bubbles and with their diameter.

Experiments by the writer indicate that below a certain critical size of bubbles the speed falls off with the diameter. Hence, the efficiency of the air should increase with the square of the degree of subdivision. In other words, bubbles one-fourth the critical size would be 16 times as efficient as critical-size bubbles, from the standpoint of oxygen absorption. This presents very fascinating possibilities in economy, but subdivision and prevention of coalescence under the severe working conditions in the aërating tanks are not quite as easy as they may seem.

Critical Size of Bubbles in Water

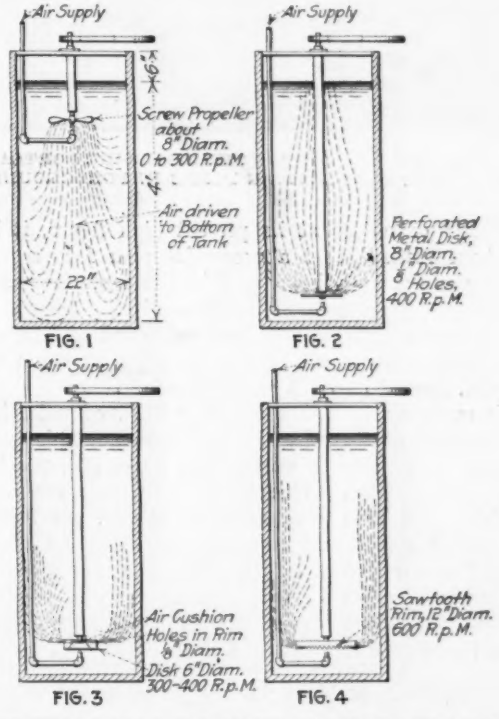
The critical size of bubbles in water is in the neighborhood of $\frac{1}{16}$-in. diameter. When larger than this, their velocity remains practically constant; when smaller, their speed, as has been stated, falls off directly with the diameter. Bubbles have a tendency toward a certain normal size, determined by the surface tension of the liquid. If they are larger than normal size, they tend to subdivide; if smaller, they coalesce. The normal size for water does not seem to be sharply defined, but lies somewhere between about $\frac{1}{16}$-in. diameter, or critical size, and $\frac{5}{32}$ in. It may be that normal size represents the establishment of truly spherical shape. Large bubbles are lenticular, and very large ones have irregular trailing faces; but the smaller ones appear to be truly spherical. Critical size seems to mark the transition from a corkscrew or zigzag ascent to a straight-line ascent.

As bubbles below normal size tend to coalesce, it is evident that fine bubbles cannot be concentrated too thickly. They must have a certain amount of room in which to maneuver. This makes it very difficult to get good results from any form of spray nozzle, such as used by Mr. Coulter, as the subdivided air must necessarily be delivered through a comparatively limited cross-sectional area; and the bubbles therefore coalesce to approximately normal size.

The writer performed a few experiments with spray nozzles and can corroborate Mr. Coulter's experience with them. The writer also tried mechanical beaters, etc., before the fundamental difficulty in delivering the subdivided air dawned upon him.

Several Devices Tried Failed To Break Up Volume of Air

It may be interesting to describe some of the devices used. The first was a screw propeller (Fig. 1). The air was well pulverized, if fed in very small amounts. Large amounts first made bigger bubbles and then very quickly stopped all propelling action of the screw by forming an air pocket around it. The revolving perforated disk shown in Fig. 2 was then tried. This did somewhat better, but the friction of the whirling disk was so great as to destroy any possible gain. The modified form in


Air Supply
Screw Propeller about 8" Diam. 0 to 300 R.p.M.
Air driven to Bottom of Tank
22"
FIG. 1
Air Supply
Perforated Metal Disk, 8" Diam. 1/8" Diam. Holes, 400 R.p.M.
FIG. 2
Air Supply
Air Cushion Holes in Rim 1/8" Diam. Disk 6" Diam. 300-400 R.p.M.
FIG. 3
Air Supply
Sawtooth Rim, 12" Diam. 600 R.p.M.
FIG. 4

MECHANICALLY OPERATED AERATORS TRIED IN MILWAUKEE ACTIVATED-SLUDGE STUDIES IN 1915 WERE NOT PROMISING

Fig. 3 and 4 were then employed with the idea of eliminating disk friction on the lower side by means of a partial or complete air cushion. Neither of these was successful in breaking up any respectable volume of air, the defect, of course, being inherent in the very principles involved.

In order to work the activated-sludge process with finely divided air, 25 to 50% of the tank area must be diffusing area or the bubbles will coalesce very rapidly, no matter how finely they may be subdivided to start with. It seems to the writer that this fact practically eliminates nozzles and mechanical beaters from consideration, and he has therefore devoted his time to the perfection of fine-bubble diffuser plates. These experiments are now practically concluded and will very shortly be ready for publication.

Concentrated Potash a Byproduct of Cement Mill

After-Treatment To Dilute Potash from Precipitation Process Gives 6 Lb. Potash per Barrel of Clinker

POTASH RECOVERY PLANT AT THE RIVERSIDE PORTLAND CEMENT CO.; EVAPORATING PONDS IN FOREGROUND

WITH potassium at its present high figure, it has been realized that a successful plan for recovery of this element as a byproduct in the manufacture of cement would prove most remunerative. Efforts to discover such a process have been redoubled of late, and success has finally come to the Riverside Portland Cement Co., located in southern California.

This company is now recovering 6 lb. of potassium sulphate for every barrel of clinker burned. This quantity at present prices is worth from 40 to 50c. per bbl. of cement produced. On the pre-war basis the same material would have a value of about 18c. per bbl., a figure which would still leave an attractive net profit, so that the new branch of the industry is not likely to be shortlived. The following statement was obtained by *Engineering News-Record* from John Treanor, manager of the Riverside Portland Cement Company.

Analyzing Material and Processes

Clays and shale suitable for portland-cement manufacture vary in K_2O content up to values as high as 2½%. During the past year many portland-cement raw mixtures from Eastern manufacturers were examined in the Riverside laboratories and were found to contain from 0.8 to 1.25% of K_2O.

In the ordinary burning of portland-cement raw mix, from 40 to 50% of potash content is volatilized and leaves the kiln with the kiln dust. This volatilized potash can be recovered in the form of a more or less dilute salt by the installation of suitable dust-collecting systems.

The amount of potash recovered depends upon the efficiency of the collecting devices. The efficiency of the electrical precipitators varies from kiln to kiln; the best individual kilns give results as high as 80% of the potash volatilized, while individual treaters over other kilns have an efficiency as low as 55%. A 100-ft. rotary kiln, for example, may produce anywhere from 4 to 7 tons of dust daily, whose average potash content may range between 4 and 10%.

The potash contained in this dust is usually water soluble; or if part is insoluble, it will be amenable to further chemical treatment. This potash containing dust recovered from the kiln gases can be sold as dilute fertilizer just as it is. In fact, such a byproduct is regularly being produced by the Security Portland Cement Co., at Hagerstown, Md. (*Engineering News*, Dec. 28, 1916, p. 1222), and by the Alpha Portland Cement Co., at its plant on the Hudson River.

Dust Used as Fertilizer

The use of this dust, however, is restricted to agricultural operations requiring a lime-base fertilizer. It cannot be conveniently used as an ingredient for a complete fertilizer, on account of its dilute form. The cost of freight upon 90% of inert material is burdensome, reduces the net selling price and limits the available market. The usual requirements for complete fertilization work is a salt whose K_2O content is not under 35%, and it is toward this ideal that efforts have been directed in striving for a process for recovering potash from cement plants.

The potash recoverable from all cement kilns under all conditions will be in the form of potassium sulphate. During the past five years the laboratories at Riverside have been working on the problem of deriving a more concentrated salt from this dust. One of the obstacles, however, was that only 50 to 55% of the total K_2O originally present in the dust could be extracted in water-soluble form.

Recently it has been discovered that the cause of this poor extraction was the formation of a double salt of potassium and calcium sulphate which at ordinary temperatures has a low degree of solubility. This double salt is the mineral syenite, occurring in nature. After the cause of the poor extraction was known, it needed but a step farther to remedy it; and it was finally found that by keeping the mixture at a minimum of 85° C. during the leaching and filtering process, and maintaining proper conditions of concentration, all of the water-soluble potash originally present in the dust could be recovered. Patent No. 1,220,989 is based upon this simple fact.

Percentages Recovered

For every 1% of K_2O in the raw mixture it would be theoretically possible with this process to recover 6 lb. of K_2O from each barrel of clinker, provided the volatilization is complete. Upon the pre-war basis of 3c. per lb., this would amount to 18c. per bbl., so that any economical means by which could be accomplished a better volatilization of K_2O from the clinker would be decidedly worth while. Working toward this end, a process was developed (patent No. 1,194,344) which makes use of calcium fluoride as a reagent for increasing the volatilization of potassium salts from the clinker and the regeneration of the reagent from the dust collected. This is accomplished as follows:

For every 1% of K_2O present in the raw mix, approximately 0.8% of calcium fluoride is added. This addition permits the formation of potassium fluoride, which is readily volatile and has a boiling point of about 850° C. The reaction between the calcium fluoride and the

potash in the raw mix, however, does not take place until a temperature of about 1100° C. is reached. At this temperature, which is far in excess of its boiling point, the salt will be rapidly expelled from the raw mixture and carried off with the gases of combustion and the dust.

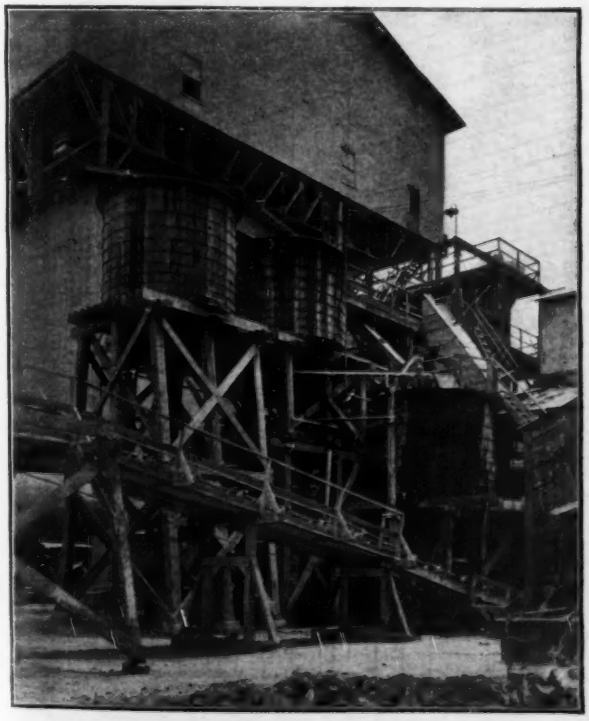
This volatilized potassium fluoride, however, does not persist in this form. It is more or less completely converted by the oxides of sulphur in the gases of combustion to potassium sulphate. This transformation is accompanied by the liberation of hydrofluoric acid, which is immediately neutralized by the lime compounds in the dust and is converted into calcium fluoride. This dust is then leached by the process already described, and the soluble potassium sulphate is separated from the insoluble calcareous and argillaceous material by filtration.

Results of the Process

The filter cake obtained by this operation is useful raw mix, containing in addition to cement-making substances all of the calcium fluoride originally used, and in addition to this the deleterious constituent, lime sulphate.

Originally it was attempted to enrich the dust by reburning it; and although this gave a very rich potash dust, the operation was extremely uneconomical. In fact, only 20% of the total potash fed into the kiln in the shape of stack dust and treater dust was volatilized. The remainder, or 80%, was driven into the clinker.

The cause of this was found to be the calcium sulphate present in the dust. In the presence of fluoride, however, the calcium sulphate decomposes, which discovery was embodied in patent No. 1,219,315. This reaction then makes it possible to again return the filter cake containing among other things the calcium fluoride to the raw mix where the calcium fluoride again performs its function of increasing the volatilization of the potash in the raw mix. By this cyclic process the volatilization at the Riverside plant was increased from 60 to 90%.



HOT WATER AND MIXING TANKS AND BELT DISPOSING OF FILTER CAKE

BAGGING THE CONCENTRATED POTASH FERTILIZER

Summing up the possibilities of recovery of potash as a byproduct in portland-cement manufacture, the experience at the Riverside plant indicates that 90% of the potash contained in the raw mix can be volatilized, 10% remaining in the clinker; 80% of the potash so volatilized in the kiln should be caught by the dust collectors. The net product, about 70% of the original input, will be still further reduced about 5% by losses in filtering. It has been demonstrated by the work at Riverside that it is entirely conservative to look for the recovery, in the form of concentrated salt, of 66⅔% of the potash originally contained in the raw cement mix, and it is quite possible that even these results may be improved upon by increase in the efficiency of the dust collectors. The resultant salt is received most enthusiastically by the fertilizer trade.

Mechanical Features of the Process

The dust is drawn from bins under the electrical treaters into tanks, where it is put into solution by agitation in water of not less than 85° C. at a concentration of not over 5% K_2O. The apparatus consists merely of cylindrical tanks some 12 ft. in diameter and 8 ft. high, which have on their axis a vertical shaft carrying ordinary propellers. The tanks are filled with water to a depth of about 6 ft., and the water is brought up to the desired temperature by means of steam injected into it.

The dust is then charged into this heated water, and the temperature rapidly rises to boiling point, due to the hydration of the lime contained in the dust. Samples are taken every few minutes, filtered, and specific gravity determined as well as percentage of solids. The potash goes into solution surprisingly fast under the conditions described. The whole operation of extracting the water-soluble potash from 7 tons of dust is accomplished in less than 50 min., and the whole control has reduced itself to a very simple basis.

As soon as a batch is cooked in one of the tanks, it is run by gravity into the filter reservoir under an Oliver filter press, where its temperature is maintained by steam coils, and the whole is kept at a homogeneous consistency by means of an agitator. The suction of the filter drum then forms a cake; and as the drum revolves, this cake emerges from the pulp and encounters a bank of hot-water sprays. Suction is applied automatically

after passing this point, to remove as much water as possible from the cake, which, when it reaches the horizontal position of the floor level, is scraped off by means of a plow.

The solution thus extracted from the cake is passed directly to storage tanks, which are at the same time settling and evaporating ponds by means of solar evaporation, which is very active in the dry climate of southern California. When the liquid has attained a specific gravity of about 1.1%, it is pumped to the evaporating pans, where the liqued level is maintained at a fixed point and the solution becomes more and more concentrated and the salt drops to the bottom. It is then raked out upon a drain board, where it is allowed to remain some minutes, and thence is deposited in a hopper, where draining continues for several hours. From this hopper it is passed through a rotary drier, thence through a Williams mill where it is reduced to the desired fineness; and finally the salt proceeds to a bin under the sacking machine.

Credit for the invention of the chemical processes employed belongs to Frederick W. Huber, chief chemist of the Riverside plant, and to his assistant, Frank F. Reath.

Diagrams Facilitate Design of Office Building and Mill Building Columns Under Eccentric Loads

Built-Up I-Sections of Typical Sizes Can Easily Be Selected When Length, Load and Moment Are Known

By W. S. WOLFE

Instructor in Architectural Engineering, University of Illinois, Urbana, Ill.

DIAGRAMS that are easily constructed and reduce to a marked degree the labor required in designing and checking columns subjected to combined axial and bending stresses, such as are produced by eccentric loads, are here shown for typical built-up I-sections.

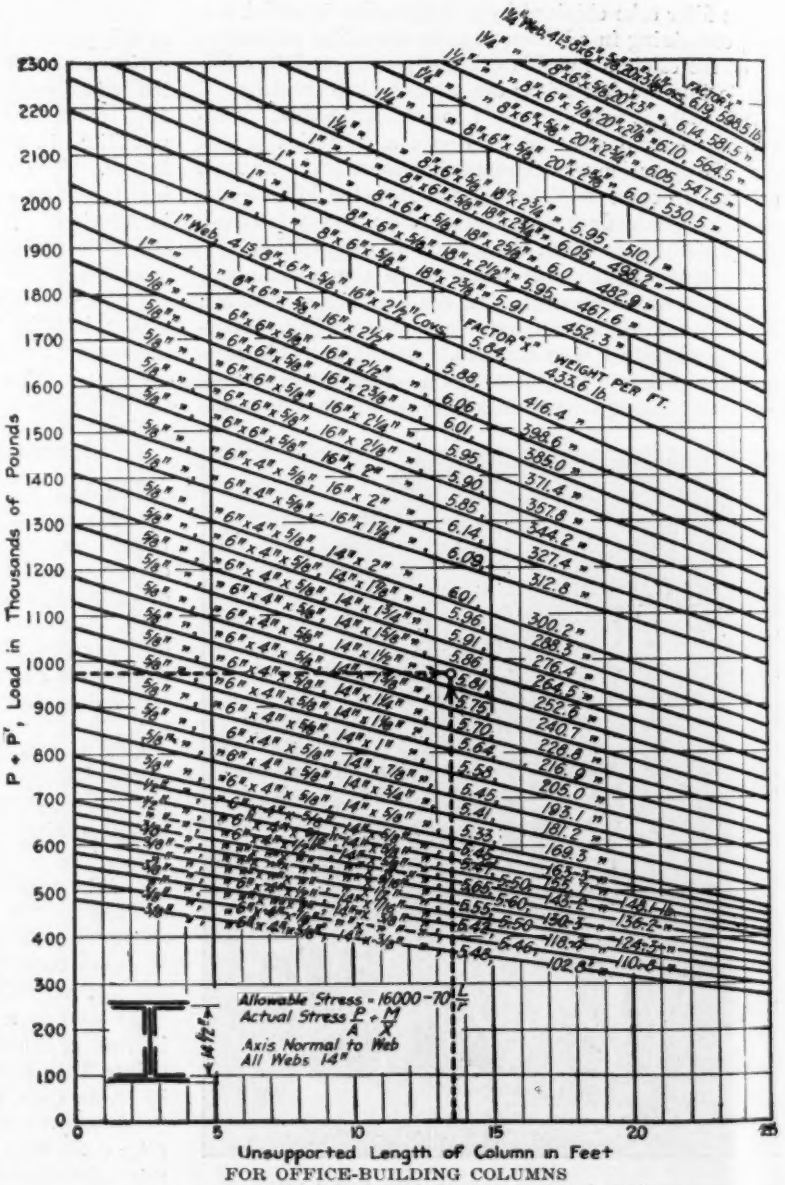
One diagram as reproduced is applicable to the design of mill-building bents, and the other to office buildings. No claim is made for completeness, as the variety and kind of sections is of course very large; but the simple principles upon which the construction of the diagrams is based are given. Hence, additional diagrams can be prepared by anyone to satisfy the particular types of column and column formula used.

Theory of the Diagrams

The approximate formula for maximum fiber stress f is

$$f = \frac{P}{A} + \frac{Mc}{I}$$

in which P is the total direct load in pounds; A, the area of the column section in square inches; M, the bending moment in inch-pounds; c, the distance to the extreme fiber; and I, the moment of inertia about the axis perpendicular to the plane of bending. Let P' be a direct load of such magnitude as to produce the same unit


P + P', Load in Thousands of Pounds
Unsupported Length of Column in Feet
Allowable Stress = 16000 - 70 L/r
Actual Stress P/A + Mc/I
Axis Normal to Web
All Webs 14"

FOR OFFICE-BUILDING COLUMNS

fiber stress as the bending moment M; that is,

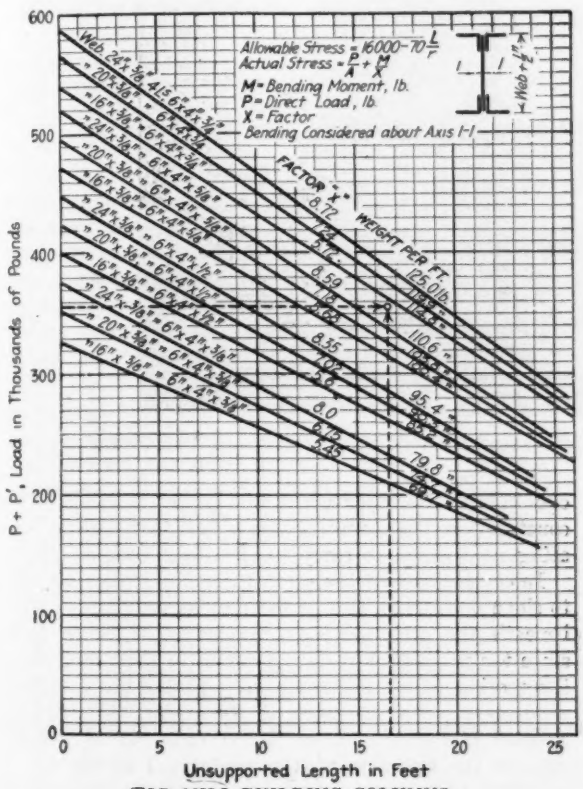
$$\frac{P'}{A} = \frac{Mc}{I}$$

or

$$P' = M \div \frac{I}{Ac} = \frac{M}{x}$$

if $I/Ac = x$, a variable depending only on the properties of the given sections.

Using the well-known straight-line formula for allowable unit stress, $p = 16{,}000 - 70L/r$, a diagram is



FOR MILL-BUILDING COLUMNS

constructed showing straight lines for allowable total load ($P + P'$) in terms of unsupported length L. On these lines the values of x are marked, also the weights per foot for comparison. The diagrams here shown have X computed for the neutral axes normal to the webs only.

How To Use Diagrams

The use of the diagrams either to investigate a given column or to select the proper section is almost self-evident. For example, given the section, direct load P, bending moment M and length: Find the line on the diagram which corresponds with the given section, read the value of x, divide it into M to get P', add the result to P and follow this sum $P + P'$ on this left-hand scale horizontally to intersect the vertical line for unsupported length. If the intersection is below the line representing the column, the allowable load is greater than the existing equivalent load, and the column is safe.

Similarly, if a column is to be designed for given loading, bending moment and unsupported length: Assume a section that seems reasonable, get the corresponding value of x from the diagram, compute $P + P'$ as before and obtain the intersection of the horizontal line for this load and the vertical for the unsupported length. If this intersection falls below the sloping line representing the assumed column, it is strong enough.

Of course, several sections may have to be tried, and the economical section will be found where the intersection and column line coincide. The advantage of the diagrams lies in the ease with which various sections can be investigated and the economical section obtained.

Effect of Fire on Reinforced-Concrete Buildings Analyzed

The destruction by fire of reinforced-concrete buildings at the plant of the Quaker Oats Co., Peterboro, Can., brings out some interesting points as to the effect of high temperatures upon structures of this kind. The fire and its effects were reviewed in *Engineering News-Record* of Apr. 5. The following additional notes are from a paper read before the Western Society of Engineers by T. D. Mylrea, engineer of tests of the City Architect's Department of Toronto, who made a thorough inspection of the buildings.

The intensity and duration of the fire are given as the main cause of the failure and collapse. It is estimated that temperatures of over 2300° F. were reached; and in the standing portion of the building the fire burned for several days, while in the collapsed portion there was considerable heat and fire even after two months. It is true that there was no fusion of the concrete, but this is due to the fact that the aggregate was limestone, which does not fuse.

In the Edison fire at West Orange, N. J., the aggregate was a variety of traprock that fused at about 2200°. In the Quaker Oats fire the 9-in. slabs heated to a degree sufficient to destroy the crystal form of the cement in the concrete and to reduce the strength of the reinforcing rods to practically nothing. Mr. Mylrea states that intensity of heat as the cause of failure of a concrete structure seems never to be considered.

"In the recent controversy over the recommendations of the Joint Committee on flat-slab regulations, both sides seem to have overlooked the effect of fire on the structures. All extensometer tests show that the stresses developed by a given load are less than the computed stresses, and this fact is variously assigned to 'dome action,' 'slab action' and 'tension resisted by concrete.' This fire brings forcibly to mind that it is possible for all these factors to be eliminated in an existing structure, and undue dependence should, therefore, not be placed upon them.

"As to the question of the amount of fireproofing required, the complete dehydration of the floor slabs proves that it is possible to raise the temperature of a 9-in. slab to 1250° F. completely through. This would show that it is possible to reduce the strength of the steel by about 50%, even if placed 4½ in. from the surface. The depth of calcination of the aggregate shows that a temperature of 2000° F. was reached at a point more than an inch from the surface. These facts show that it is impossible to afford absolute fire protection to the reinforcement and do so economically."

Bascule Bridge at Syracuse Typical of New York Canal Crossings

Skew of 23° Led To Using Fixed Floor Over Counterweight Pit —Small Movable Sections Along Girders Provide Clearance

By ARTHUR G. HAYDEN

Bridge Designer, Barge Canal Office, Albany, N. Y.

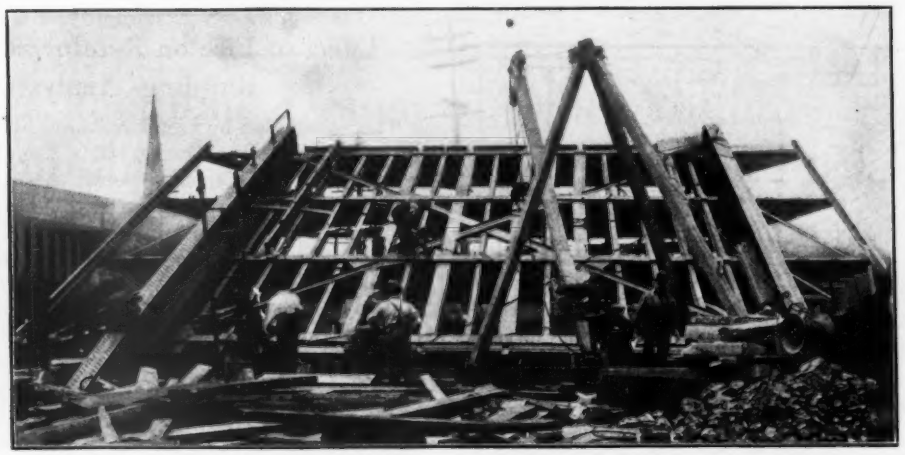


FIG. 1. SKELETON OF WEST GENESEE ST. SKEW BASCULE OVER ERIE CANAL AT SYRACUSE

SHORT-SPAN bascule bridges of the trunnion type, of which several have been built in recent years by the State of New York, often involve special problems. The most recent, the West Genesee St. bridge over the Erie Canal in Syracuse, N. Y., is complicated by a skew of about 23°, for which reason the floor over the counterweight pit was made stationary instead of part of the moving structure. The tail of the bridge is wholly below this floor (Fig. 1).

The arrangement of structural parts is shown in Fig. 3. The main girders (two) are supported on trunnion pins whose axes are in the same line and parallel to the front wall of the pit. The pins are therefore skew with the center line of the girders, which are supported on them by means of cast steel bearings (Fig 5) to which the pins are keyed.

The lift end of the bridge is parallel to the trunnion line, as are also the floorbeams, which makes the bending moments and consequently the counterweighting alike for the two girders. This condition would not hold if the intermediate floorbeams were placed square to the main girders.

The bridge is balanced by a concrete counterweight carried on extensions of the main girders back of the pins into the counterweight pit. The floor over the counterweight pit is stationary; it consists of longitudinal I-beams between which are sprung concrete arches.

Back of the trunnion pins the bascule girders descend through openings in the floor when the bridge is raised. This construction makes unnecessary a heel lock with its operating mechanism to carry the live-load back of the pin.

In consequence of the skew, the main girders are made to slope downward back of the pins as rapidly as possible beneath the pit floor. As the bridge is being raised, since the main girders do not rotate in their own planes, the motion of all points on each girder has a sidewise component out of the plane of the girder. Consequently a small triangular portion *MNO* (Fig. 3) of the floor back of the trunnion pins is made part of the moving structure to provide a clear opening for the parts of the girder above. The size of the moving sections of the floor is determined by the point where the girder passes beneath the pit floor when down and it is obviously of advantage to have this as small as possible, consistent with other clearances. In the case of square bridges the girders rotate in their own planes and may be carried to their full height to the back of the pit, the openings through which they descend being entirely in the sidewalks and equal only to the girder width plus clearance. (See description of Franklin St. bridge, Syracuse, *Engineering News*, Sept. 21, 1916.)

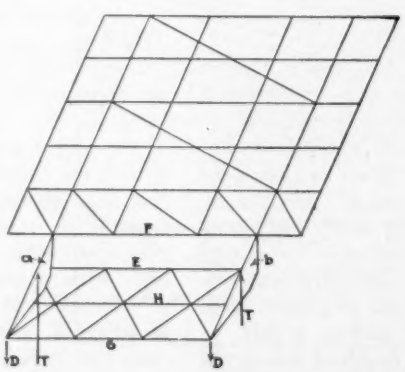


FIG. 2. SCHEME OF BRACING TO CARRY DEAD WEIGHT IN RAISED POSITION OF BRIDGE

On account of the skew, the lateral bracing performs an important function in carrying the dead-load of the bridge when raised, as will be seen from the diagram, Fig. 2, the plane of the paper being supposed vertical. Here the reactions at the trunnion pins are shown by *T*,

the counterweight loads by *D*, the trunnion end floor beam by *F*, and the limits of the lateral bracing back of the pins by *E* and *G*. The bridge floor proper ends at the front wall of the counterweight pit, finishing against an apron attached to the trunnion end floorbeam *F*. The front wall of the pit interrupts all steel work between *E* and *F* (see Fig. 1) except the main girders and parts of the wing girders *a* and *b*, for which recesses are made in the wall. The wing girders *a* and *b* are attached to the bottom flange of the main girders, are perpendicular to the main girders and when the bridge is raised carry the sidewise bending moments (due to the dead loads) across the gap between *E* and *F*, at which point the lateral bracing is interrupted.

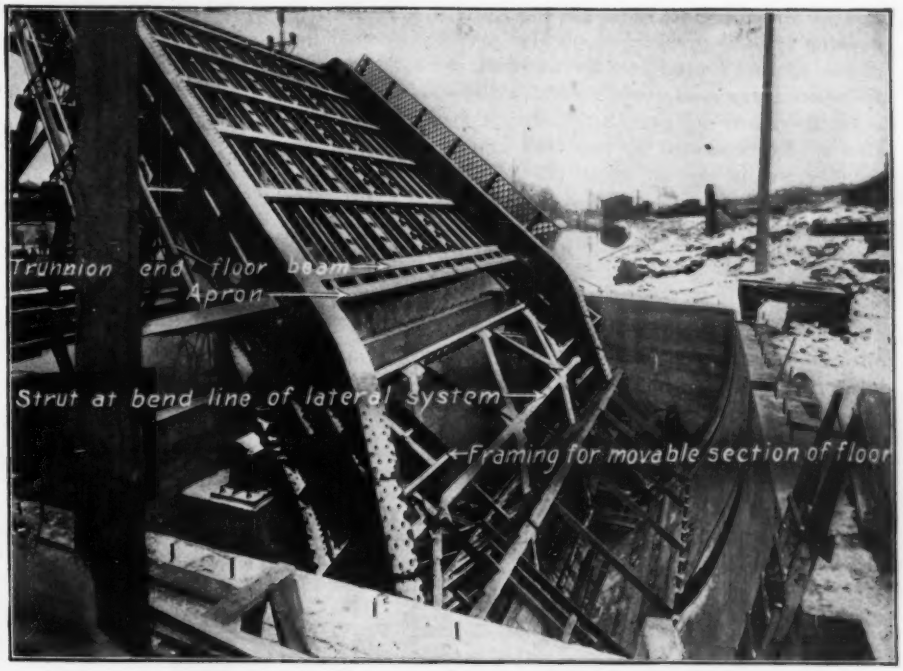


FIG. 4. TAILPIT DURING ERECTION SHOWS FORM FOR COUNTERWEIGHT

All lateral bracing is in the plane of the bottom flange of the main girders and is deflected downward at strut *H* (see Fig. 1) so as to terminate near the line of center of gravity of the counterweight. The lateral system is so designed that there is no computed component of stress perpendicular to the plane of the laterals at the bend line on strut *H*.

Two of the four lines of track stringers serve to carry the dead weight of the floor, when the bridge is raised, to the intersection points of the laterals in the fifth panel from the top and thence to the main girders.

The operator's house is placed on the side of the canal opposite the counterweight pit so as to obtain a clear view of the canal when the bridge is raised. All operating machinery (the racks excepted) is carried on the concrete counterweight and is a part of the moving structure. Two 20-hp. electric motors, placed at one end of the counterweight, drive through a train of gears the two rack pinions, which mesh with racks placed on the curved backwall of the pit. (See Fig. 3.) Each motor is operated by a drum controller having eight points forward and eight reverse, installed in the operator's house. The cable conveying the current from the controllers is carried through a tunnel under the bed of the canal. The cable terminates in a knife hinge, by means of which the current is delivered to the motors, one arm being attached to the front wall of the pit and the other to the moving part of the bridge.

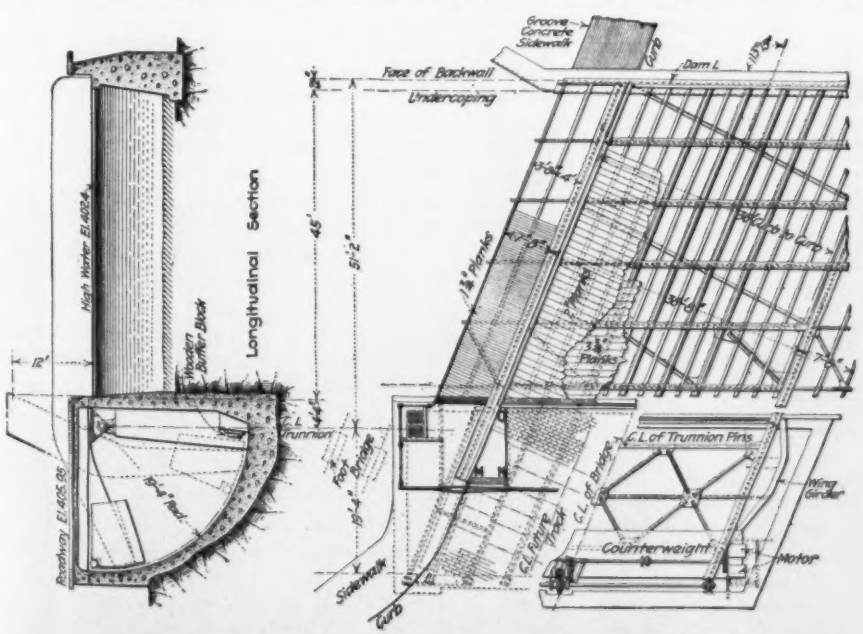


FIG. 3. GENERAL PLAN OF WEST GENESEE ST. BRIDGE

Each controller is equipped with a gear on the cylinder shaft meshing with an idler connecting the two gears. Each gear is in two concentric parts which will move independently of each other unless a pin is placed to lock them together, so that it is possible to operate either motor independently of the other, or both in parallel. Ordinarily both motors work together, but in case of accident to either the damaged motor may be thrown out of train

and the bridge operated with the other. With both motors working at 50% overload the bridge may be operated in 70 sec. against a wind pressure of 15 lb. per sq.ft., ample allowance being made for friction in the machinery.

In the closed position, the bridge is locked by means of a toe lock operated by rods, bell cranks and lever, of the type used in railroad signal towers. The lever, located near the controllers in the operator's house, is electrically interlocked with them, so that it is impossible to operate the bridge unless the bolt is in the withdrawn position.

Two mechanically operated safety gates are located at each end of the bridge. Those at the end near the operator's house are operated by rods, bell-cranks and a lever of the same type used for the lock bolt, and are mechanically interlocked with the lock-bolt mechanism to insure the gates being lowered before the lock bolt is withdrawn and not raised until the lock bolt is in the closed position. The two gates at the trunnion end of the bridge are operated by means of cables attached to the bridge counterweight.

Loading—The bridge was designed to carry the following loads at 16,000 lb. per sq.in. unit stress:

Two lines of 50-ton electric cars, with 25% impact; two 15-ton motor trucks on any part of the roadway, with 25% impact; uniform load of 150 lb. per sq.ft. on any part of the roadway not occupied by the concentrated loads; 100 lb. per sq.ft. of clear sidewalks.

Chicago Meters Only 21% of Its Water

Only 21% of the total amount of water pumped from Lake Michigan into the Chicago mains passed through meters in 1916. The city used an average of 620,000,000 gal. daily, equivalent to 249 gal. per capita and 2066 gal. per tap. Of the 20,768 meters in use, 1329 were put in service during the year; but the whole number covers only 6.9% of the service pipes, although 47.2% of the receipts are received from metered water.

Vagaries of Expansion and Contraction Movements

Unexpected irregularity of expansion and contraction movements in the steel-frame superstructure of the 3000-ft. municipal pier at Chicago is stated to have been one of the main causes of trouble with the concrete floor slab and concrete incasement of the steel floor-beams, noted in *Engineering News-Record* of Apr. 26, p. 829.

Expansion joints were provided at intervals of 100 ft., with provision for the steel longitudinal beams to slide upon their supports and for the concrete slab to move upon felt strips upon the floor-beams. The joints were designed to allow ample movement at each point. Actually, however, the movement of the steel frame did not distribute itself in this way, but concentrated at two of the expansion joints near the midlength of the pier and 100 ft. apart. Here, bolts in the slotted holes were sheared off, the movement being greater than that provided for by the slots, although the beams are stated to still have ample bearing upon their supports.

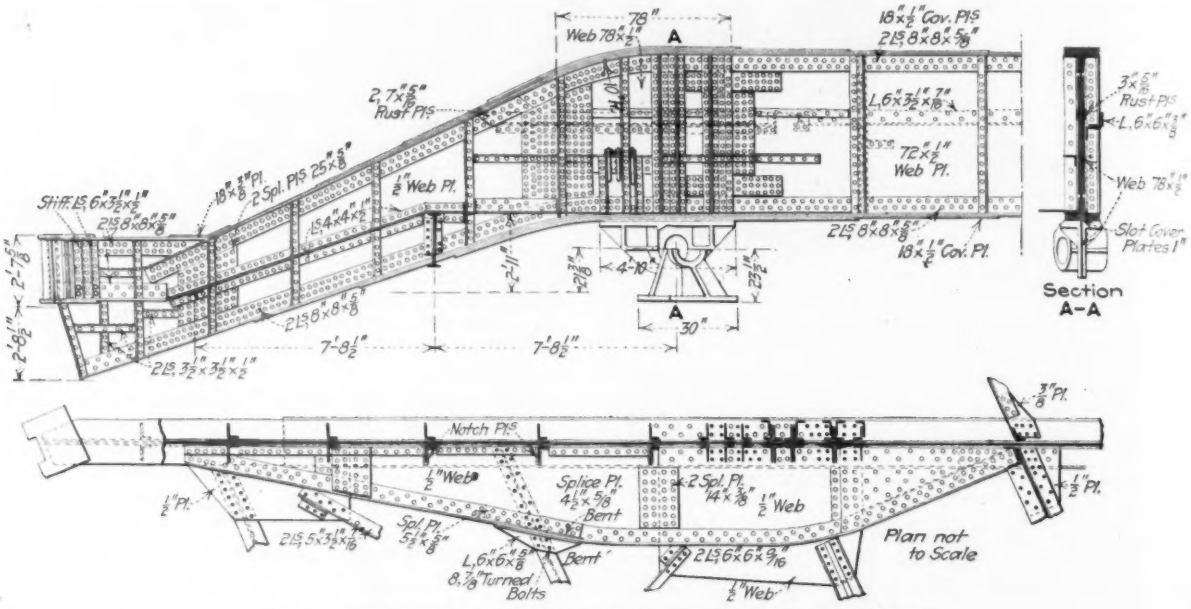


FIG. 5. TRUNNION AND GIRDER OF WEST GENESEE ST. BRIDGE

At other points the relative movement of the concrete slab on the steel framing was sufficient to crack the slab free from the concrete incasing the I-beams, as already described. It has been suggested that this trouble might have been avoided by making a joint in the concrete casing under the floor-beam as well as in the slab on top of the beam. On the other hand, it is thought that, with such irregular and unexpected movements as did occur, there would have been some trouble in spite of any such additional provision. Another afterthought was the placing of a small copper gutter under each expansion joint in the slab, to prevent any water from working down between the concrete and the steel. If such a plan had been proposed originally, it probably would have been considered unnecessary and its cost prohibitive, while its efficacy is held doubtful in view of what actually happened. In any case, as already explained, the troubles did not affect the strength or stability of the structure.

Dock Wall Built for a River-Front Building

Proximity to Seven-Story Structure at Chicago Made Underpinning Important Feature of Work

A 420-FT. concrete dock wall on the Chicago River has been built to improve the frontage of the J. V. Farwell & Co. property between Adams and Monroe Sts. The face of the wall being only about 8 ft. from a seven-story building, special care was necessary to avoid disturbance of the building foundations, which were strengthened in connection with the other work. The construction is shown clearly in the accompanying drawings.

The original dock wall or bulkhead consisted of a row of round piles 2 ft. apart, with timber cap and fenders, and was backed by three lines of 3-in. wood sheet piling to retain the fill. For the new work the piling was cut off about 12 in. below the water line, and a 12 x 12-in. wale was placed on the outside. When the work was ready for concreting, the sheeting was cut to grade. Fig. 1 is a typical section of the work.

To hold the piling in position while the building wall was being underpinned and the concrete placed for the dock, tie-rods were run from the waling timber to an anchorage behind the footings of the second row of interior columns of the building. The first row is only indicated on the drawing. This anchorage consisted of a pair of 12-in. steel channels laid flat, back to back, with steel separators between them so as to give room for the rods to pass through. The channels are embedded in concrete, which is filled in against the back of the footings in order to give ample bearing.

Timber forms were built along the front of the dock and anchored to the wall of the building. The water was not pumped out, the cutting of piles and placing of new wales being done in the water, only about 2 ft. below the surface. The concrete of the base of the wall was deposited in the water. The fill behind the old sheet piling was cleared away to a depth of about 18 in. below the water, and planks laid between the round piles served as the bottom for the front part of the form.

The concrete was a 1:3:5 mix (made with stone), care being taken to secure a dense mass and surface. It was made in a floating plant and spouted into place. The wall was built in sections about 50 ft. long. No fender timbers were placed along the face of the wall. Mooring posts were proposed, these being hollow castings fitted upon and grouted to pipe anchors embedded in the wall, as shown. However, the old snubbing anchors were used instead.

As noted above, the work included the strengthening of the foundations of the building. The front wall was carried by piles capped by a timber grillage above the water line and embedded in the earth-fill. This wall was underpinned to permit removing the grillage and cutting off the pile heads to about 1 ft. below water. Then a continuous concrete footing was put in, extending 6 in. below the tops of the piles. The interior columns had masonry footings in good condition.

For the permanent anchorage of the new footing and dock wall, 1¼-in. rods were run from the steel channel anchors, previously mentioned, to large washer plates embedded in the new concrete footing. Other rods are attached to similar plates in this footing and extend into the base of the concrete wall. At each column footing there are two tie-rods, which are cased in concrete. Between the footings of the first and second rows of interior columns the concrete casing is increased in width so as to form struts between the footings. In this way both rows of footings are utilized as anchorages.

At one corner of the building four caisson (or concrete-pier) foundations were put in on account of the necessity of cutting off the projecting footings of the north wall for placing the abutment for the new Monroe St. bridge. One of the concrete piers was placed beneath the corner of the building, two others about 18 ft. each way from the corner, with the fourth under a heavy vault. They carry the load to hardpan at a depth of about 65 ft. below water. The three outer piers are 5 ft. in diameter, belled out to a bottom diameter of 10 ft., where they rest on the hardpan. The pier under the interior corner is 4 ft. in diameter, belled out to a 6-ft. base. Lines of I-beams, embedded in concrete, rest on the piers and form girders to support the walls of the vault and building.

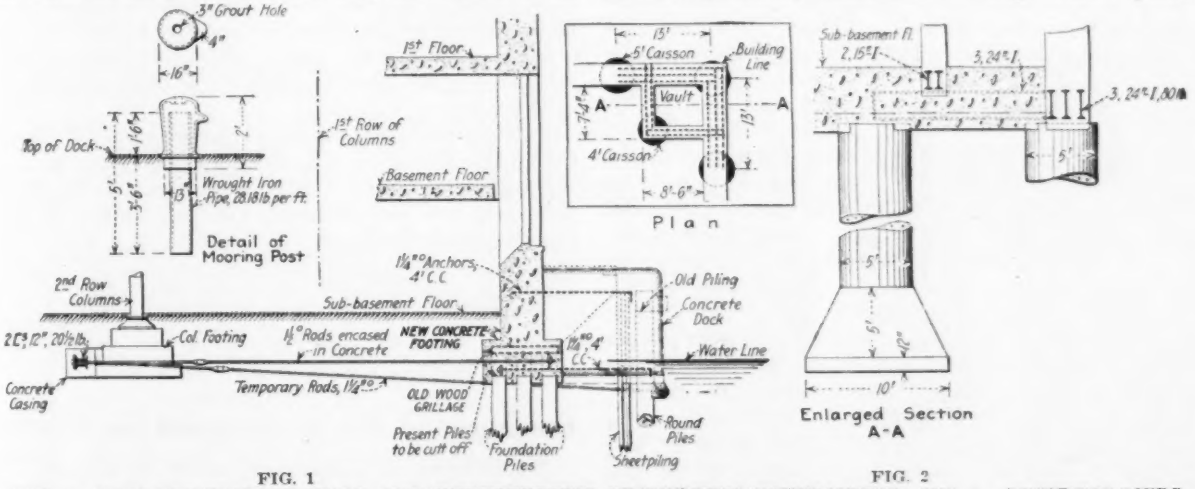


FIG. 1 FIG. 2

FIG. 1. NEW RIVER-FRONT WALL AND UNDERPINNING OF BUILDING FOUNDATIONS. FIG. 2. CONCRETE PIERS CARRY CORNER OF SEVEN-STORY BUILDING

The dock wall and the reinforcement of the building foundations were designed by E. C. & R. M. Shankland, of Chicago, as consulting engineers for Perkins, Fellows & Hamilton, architects for the owner. The Ruud-Nilsen Co. had the contract and sublet the pile and concrete work to the Fitzsimons & Connell Dredge and Dock Company.

Busy Street Repaved Without Stopping Street-Car Traffic

Recut Granite Block Laid Between Rails—Asphalt Paving Is Used on the Main Roadway

REPAVING Gay St. with asphalt for the driveways and recut granite blocks for the car tracks in an important work now being carried out at Baltimore, Md. The street is 2¼ miles long, 28 to 49 ft. between curbs, and is one of the busiest thoroughfares in the city. The car line is mainly double track, but with some single track in the narrow portions. The old stone pavement has been in service about 35 years. It consisted of granite blocks 8 to 12 in. long, 4 to 5 in. wide and 6 in. deep, laid on a sand foundation and with sand filled in the joints.

In the new construction, the sides of the roadway are paved with asphalt on a 6-in. concrete base, there being a 1½-in. binder and a 1½-in. wearing surface. The old 6-in. granite curb is left in place, except where necessary to redress and reset it, but long-radius curb circles are being put in at all corners. Vitrified-block gutters about 12 in. wide are installed along the curbs. The track space between outer rails is paved with recut granite blocks on concrete, with cement filler, and two rows of granite-block liners are laid outside of each outer rail.

The street roadway is closed to traffic during the work, such crossings being kept open as may be necessary, and at least 14 days are allowed for the setting of the concrete base. The street-railway tracks are kept open for traffic throughout the repaving, this being made practicable by the use of a grouted stone ballast for their foundation. The work is divided between the contractor (for the city) and the street-railway company's forces.

Paving Done by the Contractor

The first work is the removal of the old blocks, which are loosened by means of 1-in. steel bars 6 ft. long, pointed at one end. They are hauled to adjacent lots, where they are recut for use in paving the track space. The blocks being removed, the contractor grades both the city's space and the track space down to the subgrade of the paving. He also adjusts the curb as required.

After the railway forces have done their work, as described below, and have brought the grouted ballast up to a level about 2 in. above the bottom of the ties, the contractor again takes charge. He dresses up the subgrade for the pavement and places the concrete base on the subgrade and over the grouted ballast of the track space. The recut granite blocks are then laid between the rails, the liner blocks are laid outside the outer rails, and the vitrified-block gutters are put in, all with a cement filler. After allowing 14 days for the concrete to set, the asphalt paving is laid in the roadways; and the street is opened for traffic as sections of this final work are completed.

Railway Work with Grouted-Ballast Base

When a certain amount of track space has been made ready by the contractor (as above), the railway forces take charge and grade it down to 6 in. below the bottom of the 8-ft. ties, to make room for the new ballast. The old 7-in. girder rails and hewed-pine ties are replaced with 7-in. grooved-girder rails secured to sawed-oak ties by screw spikes. The new rails and ties are placed at night (after midnight), so that cars can be operated. The next day the rails are spiked and splices bolted. Stone ballast for each track is dumped in place from cars on the other track, being distributed by moving the cars ahead while dumping. The track is then raised to grade and is lined and surfaced on the ballast.

After the track has been well tamped, mainly by compressed-air tools, a portable concrete-mixer outfit with gasoline engine is run alongside the track, and cement grout is spouted over the broken stone to fill all voids and form a grouted concrete base. The sand for this grout is dumped from cars and then shoveled over toward the curb to make room for the mixer. Wherever loose ties develop during the grouting, they are at once tamped to a solid bearing.

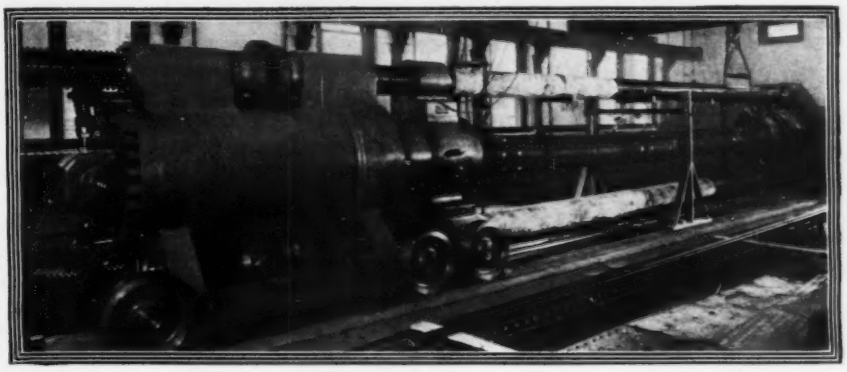
This improvement is under the jurisdiction of R. Keith Compton, chairman and consulting engineer of the Paving Commission of the City of Baltimore, with Frank K. Duncan as principal assistant. The contractor is the Baltimore Asphalt Block and Tile Co. The track work is being done by the United Railways and Electric Co., of Baltimore, with W. W. Wysor, acting chief engineer, and J. M. Hood, Jr., consulting engineer. The paving work, including that within the track space, will cost approximately $112,000, exclusive of track work.

Underground Streets Proposed for Chicago

The building of underground streets at Chicago for the use of street vehicles, electric cars and pedestrians is suggested by the Board of Local Improvements, in connection with rapid-transit developments. This step would make the proposed rapid-transit subways unnecessary. The work would be paid for partly by special assessment on the frontage property benefited and partly by drawing on the city's traction fund (55% of the net earnings of the street-railway companies) for such proportion of the cost as would represent special public benefit. The board, which deals with all improvements built by special assessment, states that its attorneys find it has the right to construct such streets by special assessment and to draw upon the traction fund as proposed.

The subway streets would extend between the property lines. Plans and estimates are to be prepared by the engineers of the board, after which public hearings will be held and an ordinance then prepared for action by the City Council. If this ordinance should be passed, the next step would be to petition the court for levying the assessment. The selection of the streets in which these municipal subways would be built will be left until after the public hearings. According to a published statement, the board considers that subways should not be built by public funds alone, but that property owners benefitted should be assessed.

Important Series of Steel Column Tests Establishes Principles of Strength



Reliable Data on Strength of Modern Steel Columns Provided by Over 200 Column Tests at Bureau of Standards—Strength Found To Depend on the Compressive Yield-Point of the Steel

THE completion of the remarkable series of column tests conducted at the Bureau of Standards during the past three years permits of presenting a brief summary of the results. This series, the largest consistent group of column tests ever made—in fact, virtually the only important modern series—lays a new experimental foundation for conclusions concerning the design and the strength of steel columns.

What the Results Demonstrate

The results demonstrate the reliability of steel columns, their efficiency in respect to utilizing the full strength of the steel, the weakness or inefficiency of tie-plated construction, and the unsuspected weakness which may be introduced by inherent qualities of the steel. It merits special remark that the tests are not only consistent but highly precise—due partly to the care used in the design, in choosing the material, and in manufacturing the columns, and partly to the skill and scientific procedure applied to the work of testing. The large Emery testing machine in the Washington laboratory of the Bureau of Standards made an excellent record of performance with these tests. Painstaking work was done by the testing laboratory force of the bureau, under the leadership of Dr. George R. Olshausen, Engineer-Physicist.

The strength figures obtained in the tests are available in entirety, though the full laboratory details have not yet been worked up. The strength figures have been published in part by the American Society of Civil Engineers and in part by the American Railway Engineering Association, whose committees on steel columns requested the tests. The results are here for the first time brought together.

Great Differences in Strength Found

The tests were based on the idea of securing uniform material for the entire series. Specifications for the steel were drawn with great care, and the limits of strength, qualities, etc., were set closer than those fixed by current commercial specifications. The mills which furnished the steel and the shops that fabricated the columns made conscientious efforts to furnish material of excellent quality, as uniform as it can be made, and yet of commercial grade.

The results indicate, however, that in spite of this fact there were very important differences of strength in the material. No one could have predicted in advance of the tests that a certain pair of columns, for instance, would not show substantially equal strength, whereas in the testing machine one of these was found to be over 30% weaker than the other. Such differences occurred again and again. They form the most prominent feature of the results of the tests. Equally large differences of strength may occur in the steel columns used in bridges and buildings, so far as any test knowledge goes.

Size and Character of the Columns Tested

The columns embraced in the tests ranged from 8.6 to 27 sq.in. in sectional area, or from less than 100 to several hundred tons ultimate load capacity. Their lengths, ranging up to 30 ft., were so chosen as to give ratios of total length to radius of gyration up to 155. The shortest were really short compression blocks, of length equal to 20 times radius of gyration. However, since the columns were tested with square ends and actually exhibited two points of inflection when loaded, the real slenderness-ratios (based on hinged or round ends) ranged from 10 to 75. In other words, the tests did not include columns as long as are allowed in standard bridge and structural practice.

Two different ideas were incorporated in the design of the test columns. The columns of one group, constituting the tests made for a committee of the American Society of Civil Engineers, were of solid section, that is without lattice, in order to furnish information on the dependence of column strength on slenderness ratio and on the shape of cross-section, and to eliminate as far as

possible the detail weaknesses likely to be present in columns assembled with lattice bars. For a like reason these columns were all tested with plain ends, the ends of the column shafts abutting directly on the heads of the testing machine; base and cap details being omitted, there was no opportunity for change in the conditions of the test on account of local yielding, except for actual body yielding.

The columns of the American Railway Engineering Association were built of open section, with connection by lattice and in some cases by tie-plates. The purpose was to deduce figures directly applicable to columns of the form most commonly used in structures other than buildings. Most of these columns were fitted with wing plates and bed or cap plates.

Tensile Tests Prescribed for Material

The material ordered for making the columns was specified to have an ultimate strength, in small-size tensile tests, of 58,500 to 61,500 lb. per sq.in. (as compared with 56,000 to 64,000 in ordinary practice) and a yield-point lying between 37,000 and 39,000 lb. per sq.in. (as compared with 36,000 in ordinary practice). Except for the divergences expressed by these figures, it is identical with regular bridge and structural steel. The control of chemical composition and rolling was in the main left to the mill, the mechanical test requirement being the goveraing one. These requirements applied to all material, irrespective of thickness or shape.

The analyses showed that practically no chemical differences existed, so that the securing of equal yield-point in the thick and the thin material must be credited to differences of procedure in the rolling mill.

Special attention should be given to the fact that the various lots of steel were made alike in tensile properties but could vary in other respects. The sequel showed that they were very far from being equal in compressive properties.

How the Tests Were Made

To prepare a column for testing, its ends were milled exactly square in the Bureau of Standards shop; as milled in the bridge shops, the ends were not sufficiently square and true for good bearing in the machine. The testing machine has only one adjustable head, and the rigid head obviously requires a truly square column-end if correct axial alignment is to be secured. The milling machine used was equipped with a special carriage running on rails bedded in the shop floor at right angles to the milling machine slides, and by clamping the column against stops on this carriage its axis was placed at right angles to the cutter-head plane.

Concentric circles inscribed on the faces of the testing machine head furnished means for centering the ends of the column quite perfectly. When in position the column was clamped by applying a load of 1000 lb. per sq.in. of cross-section. Columns having a slenderness ratio greater than 50 were counterweighted at mid-length to the amount of half the column weight.

Five Extensometers Applied

Five extensometers were applied, one at each corner and one in the middle of the top face of the column. These were roller extensometers of the Howard design read by Ames dials, attached to extension bars to span various gage-lengths up to about 20 ft. Near the ends and center, shorter-length strain measurements were made at eight pairs of gage points on 8-in. gage lengths with Berry strain gages. Attachments were made to register the center deflection of the column in two directions at right angles to each other, by means of dial gages.

The test routine was such that measurements of the set or non-elastic compression were obtained in sufficient number to permit plotting a set curve. Generally, the testing program called for running the load up by increments of 5000 lb. per sq.in. between releases (and 1000-lb. increments above 15,000 lb.), to the first pronounced change in the rate of compression. The load was then run up continuously to the maximum.

All columns were in triplicate, there being three of each length and shape. In each case one of the three was compressed considerably beyond the failure point in order to emphasize the type of buckling developed.

Normal and Abnormal Kinds of Buckling

Illustration of what was obtained by the excess deformation is furnished in the view, Fig. 1, showing columns after testing.

Integral buckling of the columns was by far the most common manner of failure, not merely at maximum load but even under the additional compression. The curve assumed by the column in such a case is exemplified by the photographs *B* and *F*, Fig. 1. Both the solid-section columns and the latticed columns failed by bodily buckling. None showed evidences of local failure (as at the end-connection wing plates, in the lattice, or in the unsupported lengths between lattice bars) prior to the point where maximum load was reached. Further, most of the columns when forced far beyond the failure point buckled into a smooth curve, showing that they developed the full efficiency of the column.

While local or detail failure was rare, some of its manifestations were of noteworthy character. The tie-plated columns of the A.R.E.A. series failed in most cases by buckling between the batten plates. That they did not utilize the strength of the metal in full degree is proved more definitely by the ultimate strengths (Table II), which show surprisingly low figures for all these columns. On the average, the tie-plated columns were only half to two-thirds as strong as latticed columns of equivalent size and length. But as explained in a footnote to Table II, the tie-plate spacing was in all cases so wide as to make the slenderness-ratio of the individual channel between tie-plates much larger than that of the whole column.

A New Phenomenon—Rotary Buckling

All the Z-bar columns of the thin sections failed in the curious manner shown by *A* in Fig. 1. The middle rotated around the column axis, while the ends (held by the machine heads) stayed in original position.

This twisting appeared to be a rotary buckling. The four outstanding legs of the Z-bars tend to buckle, and this tendency produces a tangential reaction around the column axis as center of twist. If two of the four Z-bars should tend to buckle in one direction, and two in the other, balance might exist; in all other cases the net result would be a tendency to twist the middle part of the column relative to the ends. When the twisting moment becomes great enough to overcome the torsional resistance

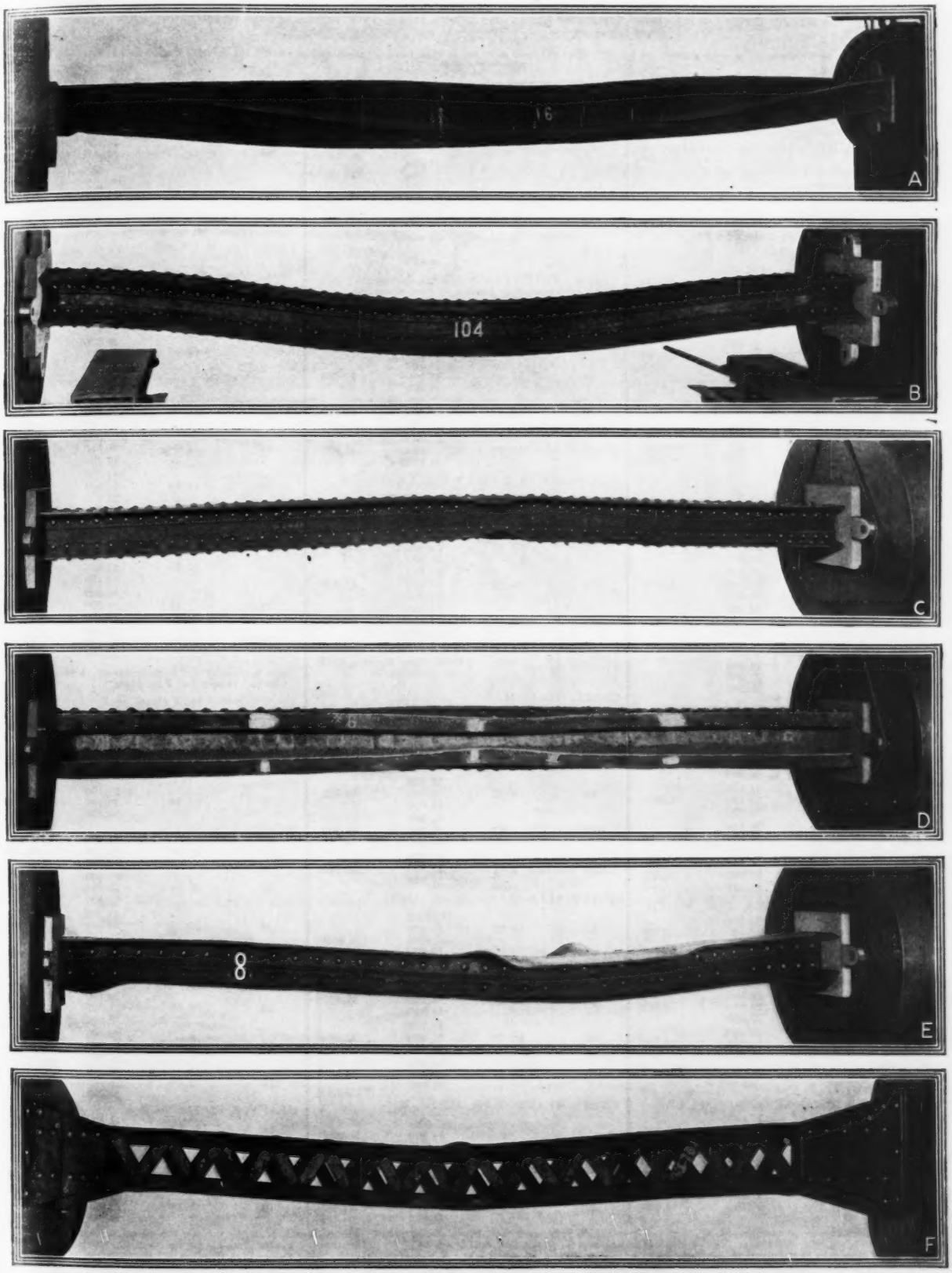


FIG. 1. SIX VIEWS SHOWING THE MANNER OF FAILURE AFTER EXCESS DEFORMATION IN THE MACHINE

A—Twisting buckling of light Z-bar columns. B—Integral flexural buckling. C, D and E—Local kinking of weak flanges. F—Integral buckling of latticed columns with local kink just starting

TABLE I. TESTS OF SOLID-SECTION COLUMNS; 198 TESTS MADE IN CO-OPERATION WITH A COMMITTEE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

NOTE—The slenderness-ratios in the tables are abnormal, as the tests were made with truly squared ends. Divide the tabular slenderness-ratios by 2 to get the pin-end values.

Slenderness Ratio l/r	Nominal Area of Cross-Section, Sq.In.	Ultimate Strength, Lb. per Sq.In.	Average
Type 1, Light; Type 1a, Heavy; Type 1b, Extra Heavy	Plate-and-angle I-section; 1 plate 6 in. wide, 4 angles 5x3 in.		
LIGHT, $\frac{3}{16}$-IN. METAL			
		[37,000]	
		38,400	
		[37,000]	[37,000]
20	11.475	38,200	38,200
		[37,000]	
		38,000	
		32,400	
50	11.475	32,800	32,700
		33,000	
		32,100	
85	11.475	31,400	31,200
		30,000	
		28,600	
120	11.475	27,600	28,300
		28,700	
		27,000	
155	11.475	25,600	26,200
		26,000	
HEAVY, $\frac{1}{4}$-IN. METAL			
		[29,000]	
		43,200	
		[30,000]	[29,300]
20	22.19	43,300	43,600*
		[29,000]	
		44,300	
		29,000	
50	22.19	28,900	29,200
		29,700	
		28,000	
85	22.19	28,200	28,100
		28,000	
		25,000	
120	22.19	25,500	25,400
		25,800	
		22,200	
155	22.19	23,200	22,700
		22,600	
EXTRA HEAVY, $\frac{11}{16}$ AND $\frac{3}{4}$-IN. METAL			
		28,200	
85	28.61	27,000	27,700
		28,000	
Type 2, Light; Type 2a, Heavy	Box section; 2 6-in. channels, 2 8-in. plates.		
LIGHT, 10½-LB. CHANNELS, $\frac{1}{4}$-IN. PLATE			
		33,100	
50	10.18	34,000	33,900
		34,500	
		33,700	
85	10.18	32,300	32,600
		31,700	
		28,300	
120	10.18	28,700	29,300
		30,900	
		26,100	
155	10.18	27,800	26,500
		25,600	
HEAVY, 15½-LB. CHANNELS, $\frac{1}{4}$-IN. PLATE			
		32,200	
50	17.12	32,500	32,300
		32,500	
		30,700	
85	17.12	30,000	30,600
		31,000	
		28,500	
120	17.12	28,800	28,100
		27,000	
		24,700	
155	17.12	26,000	25,200
		25,000	
Type 3, Light; Type 3a, Heavy	Box section; 2 5-in. channels, 2 9½-in. plates		
LIGHT, 6½-LB. CHANNELS, $\frac{1}{4}$-IN. PLATE			
		33,800	
50	8.65	34,300	34,100
		34,300	
		32,500	
85	8.65	31,800	32,400
		33,000	
		31,600	
120	8.65	30,200	30,600
		30,000	

Slenderness Ratio l/r	Nominal Area of Cross-Section, Sq.In.	Ultimate Strength, Lb. per Sq.In.	Average
HEAVY, 11½-LB. CHANNELS, $\frac{1}{4}$-IN. PLATE			
		29,800	
50	16.26	29,300	29,500
		29,500	
		28,000	
85	16.26	28,000	28,000
		28,000	
		28,000	
120	16.26	26,100	26,900
		26,600	
Type 4, Light; Type 4a, Heavy	I-and-channel section; 1 8-in. I-beam, 2 8-in. channels.		
LIGHT, 18-LB. I, 11½-LB. CHANNELS			
		35,700	
50	12.03	36,500	36,900
		38,600	
		34,000	
85	12.03	33,900	34,000
		34,000	
		32,000	
120	12.03	30,700	31,900
		33,100	
		24,000	
155	12.03	23,200	23,600
		23,500	
HEAVY, 20½-LB. I, 18½-LB. CHANNELS			
		30,300	
50	17.05	29,000	29,100
		28,000	
		26,000	
85	17.05	26,400	26,600
		27,500	
		23,500	
120	17.05	23,900	23,900
		24,200	
		23,900	
155	17.05	23,000	23,300
		23,000	
Type 5, Light; Type 5a, Heavy; Type 5b, Extra Heavy	Bethlehem H-section; 8-in. H-beam.		
LIGHT, 32-LB. H			
		[39,000]	
20	9.17	39,600	[39,600]*
		[40,000]	
		41,000	40,500
		[40,000]	
		41,000	
		38,000	
50	9.17	38,000	38,000
		38,000	
		36,000	
85	9.17	34,000	34,300
		33,000	
		31,000	
120	9.17	33,900	32,000
		31,000	
HEAVY, 62-LB. H			
		[35,000]	
20	18.27	35,600	
		[37,000]	[36,000]*
		37,800	37,000
		[36,000]	
		36,700	
		34,000	
50	18.27	36,100	35,400
		36,000	
		33,900	
85	18.27	32,000	32,300
		31,000	
		30,000	
120	18.27	30,000	30,000
		30,000	
EXTRA HEAVY, 91-LB. H			
		[25,000]	
		54,800	[25,300]*
		[26,000]	
20	26.64	56,600	55,300
		[25,000]	
		54,500	
		27,100	
50	26.64	24,000	25,200
		24,600	

Slenderness Ratio l/r	Nominal Area of Cross-Section, Sq.In.	Ultimate Strength, Lb. per Sq.In.	Average
		24,800	
85	26.64	22,500	23,400
		23,000	
		21,800	
120	26.64	21,000	21,300
		21,000	
Type 6, Light; Type 6a, Heavy	Reinforced I-section; 10-in. I, 2 11-in. flange-plates.		
LIGHT, 25-LB. I, $\frac{3}{16}$-IN. PLATES			
		31,200	
50	14.25	31,500	31,600
		32,200	
		27,800	
85	14.25	29,500	29,100
		30,100	
		26,700	
120	14.25	27,700	27,200
		27,300	
HEAVY, 35-LB. I, $\frac{1}{4}$-IN. PLATES			
		31,200	
50	24.04	32,800	32,100
		32,400	
		27,200	
85	24.04	26,800	26,800
		26,400	
		24,900	
120	24.04	24,000	24,800
		25,500	
Type 7—Bulb-Angle Column Section; 6x$\frac{3}{16}$-in. plate, 4 5-in. by 10.1-lb. bulb angles.			
LIGHT			
		34,300	
50	13.76	32,700	33,400
		33,200	
		34,000	
85	13.76	30,000	31,600
		30,700	
		28,300	
120	13.76	26,900	28,100
		29,000	
Type 8, Light; Type 8a, Heavy	Z-bar column; 4 4-in. Z-bars, 1 7-in. plate.		
LIGHT, $\frac{1}{4}$-IN. METAL††			
		35,900	
50	11.39	35,100	35,700
		36,200	
		31,400	
85	11.39	32,900	32,800
		34,000	
		29,100	
120	11.39	29,400	29,700
		30,400	
HEAVY, $\frac{1}{4}$-IN. METAL			
		33,000	
50	26.58	33,500	32,900
		32,200	
		31,300	
85	26.58	25,300†	29,400
		31,500	
		27,500	
120	26.58	27,000	27,300
		27,500	
Type 10, Light; Type 10a, Heavy	Built-up box section; 4 angles 2x2-in., 2 plates 9-in.		
LIGHT, $\frac{1}{4}$-IN. METAL			
		36,100	
50	10.89	35,700	35,800
		35,600	
		32,500	
85	10.89	31,900	32,100
		31,900	
		28,400	
120	10.89	28,300	28,400
		28,400	
HEAVY, $\frac{3}{16}$-IN. METAL			
		31,400	
50	18.71	32,000	31,800
		32,100	
		28,000	
85	18.71	28,000	28,300
		29,000	
		27,000	
120	18.71	25,900	26,300
		26,000	

* Test values for slenderness-ratio 20 (or pin-end value 10) represent short-block compression. The ultimate strengths include the effect of plastic squeezing in the heavy and extra-heavy sections. The yield-point values are, therefore, added in brackets [ ]; they are the values of basal column strength, for comparison with the ultimate strengths of the longer columns.

† No explanation for this abnormal figure was discoverable.

†† The light Z-bar columns failed by twisting (A in Fig. 4), but a strength-reducing effect of this action is not detectable in the results.

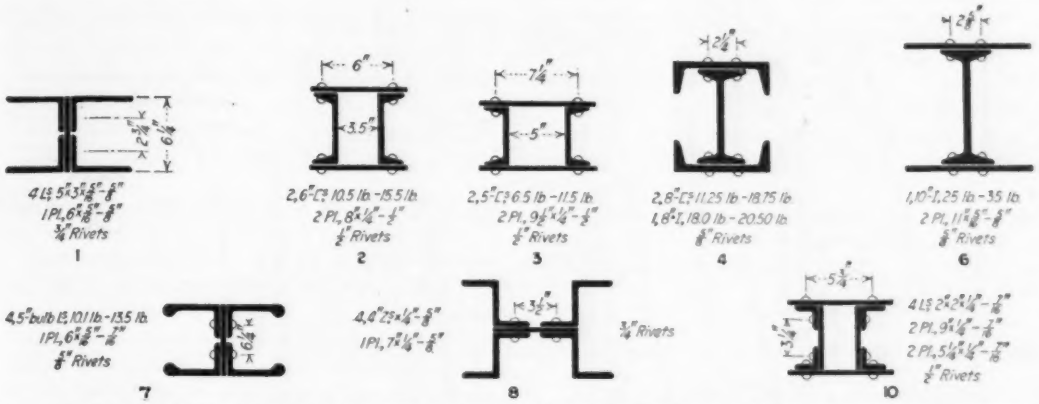


FIG. 2. TESTS OF SOLID-SECTION COLUMNS SHOWED NO INFLUENCE OF SHAPE OF SECTION. TESTED IN LENGTHS OF 50 TO 120 R, WITH SPECIAL TESTS AT LENGTHS 20 AND 155 R

TABLE II. TESTS OF 8-IN. CHANNEL COLUMNS, LATTICED AND TIE-PLATED IN VARIOUS WAYS; 42 TESTS

Made in Co-operation with a Committee of the American Railway Engineering Association

NOTE—The slenderness-ratios in the tables are abnormal, being computed as pin-end values, while the tests were made with truly squared ends. Divide the tabular slenderness-ratios by 2 to get the pin-end values.

All light columns, 2 channels 8 in. by 16½ lb. per ft.
All heavy columns, 2 channels 8 in. by 21½ lb. per ft.
Flanges turned in, spacing 10½ in. back to back.

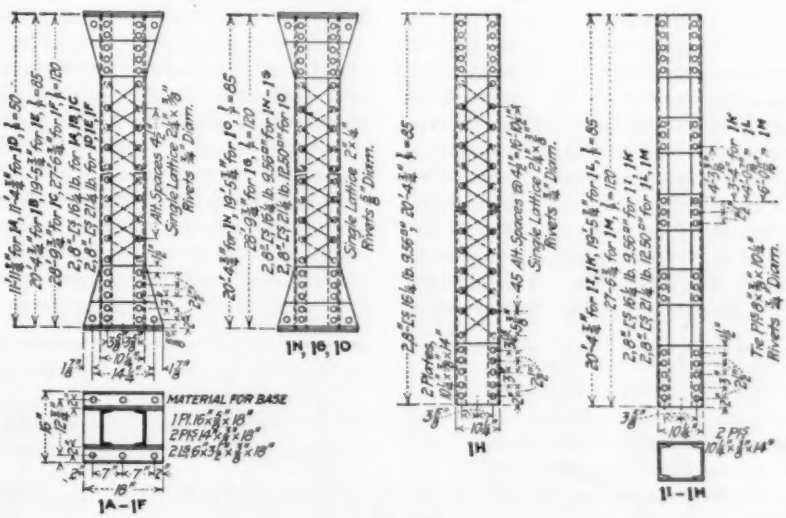


FIG. 3

Tests of latticed and tie-plated columns showed tie-plated columns to be weak—tested in lengths of 50 to 120 r

LATTICED COLUMNS WITH HEAVY LATTICE

Single Lattice 2½x¼ in., alternate spacing 4½ in., ⅞-in. rivets

Slenderness Ratio l/r	Nominal Area of Cross-Section, Sq. In.	Ultimate Strength, Lb. per Sq. In.	Average
LIGHT			
1A 50	9.56	37,900 39,300 38,200	38,500
1B 85	.....	32,900 35,000 34,100	34,000
1C 120	.....	33,000 32,000 34,000	33,000
HEAVY			
1D 50	12.50	38,500 37,800 35,400	37,200
1E 85	.....	34,000 34,900 34,000	34,300
1F 120	.....	32,600 29,000 30,900	30,800

LIGHT, WITH PLAIN ENDS

1H 85	9.56	33,900 33,900 33,900	33,900

LATTICED COLUMNS WITH LIGHT LATTICE

Single Lattice 2x¼ in., alternate spacing 4½ in., ⅞-in. rivets

LIGHT			
1N 85	9.56	33,600 33,500 34,200	33,800
1G 120	.....	34,200 32,000 33,000	33,100
HEAVY			
1O 85	12.50	32,200 31,000 32,400	31,900

TIE-PLATED COLUMNS, 8x¼-IN. TIE-PLATES 10½ IN. LONG

Three Tests, long spacing: distance between nearest rivets such that l/r (pin-end) for one channel equals l/r (square-end) for whole column.

One Test, short spacing: tie-plates spaced about ½ as far as in the preceding.

LIGHT			
1I 85	9.56	27,000 25,100 24,000	25,400*
HEAVY			
1L 85	12.50	24,200 23,100 25,000	24,100*
1M 120	.....	15,000 15,200 15,100	15,100*
LIGHT, SHORT SPACING			
1K 85	9.56	27,000 26,000 27,800	26,900*

* The tie-plate spacing represents pin-end slenderness-ratios exceeding those of the entire column by 50 to 100%. In the strongest of these tests, 26,900 for pin-end ratio of 42½, the tie-plate spacing gives a ratio in the individual channel of 65. In the lowest, 15,100, the column has pin-end ratio 60, while the channel ratio is 120.

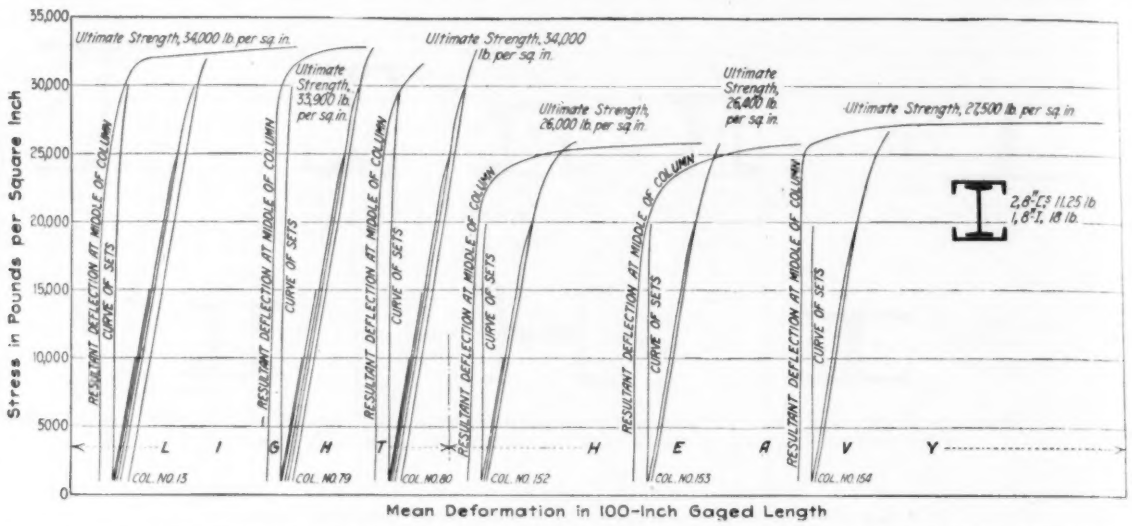

Stress in Pounds per Square Inch
Mean Deformation in 100-Inch Gaged Length
Ultimate Strength, 34,000 lb. per sq. in.
Ultimate Strength, 33,900 lb. per sq. in.
Ultimate Strength, 34,000 lb. per sq. in.
Ultimate Strength, 26,000 lb. per sq. in.
Ultimate Strength, 26,400 lb. per sq. in.
Ultimate Strength, 27,500 lb. per sq. in.
RESULTANT DEFLECTION AT MIDDLE OF COLUMN
CURVE OF SETS
COL. NO. 13
COL. NO. 79
COL. NO. 80
COL. NO. 152
COL. NO. 153
COL. NO. 154
2.8" ['s 11.25 lb
4.8" I, 18 lb.

FIG. 4. TYPICAL TEST-CURVES OF SOLID COLUMNS SHOW EXCELLENT ELASTIC QUALITIES, WITH YIELD-POINT CLOSE TO ULTIMATE

of the column core, it would produce rotation like that actually observed.

The remarkable fact is that all the light-section Z-bar columns, without exception, failed by twisting after passing the ultimate strength, while all the heavy-section Z-bar columns buckled bodily by flexure without twist.

While rotary or torsional buckling is not treated in the theoretical discussions of column behavior, it has been observed before the present series of tests. J. E. Howard, for many years testing engineer at the Watertown Arsenal, found this kind of failure in a set of Z-bar columns tested in 1891 for the Carnegie Steel Co. (This is stated by Mr. Howard; the Carnegie Steel Co. has no record of such tests, although its drawing files indicate that 22 Z-bar columns were made early in 1891 for testing.)

Failure of outstanding flanges was made apparent in a number of the channel columns, and in a few of the plate-and-angle I-section columns, by the excess straining subsequent to maximum load. The views *C, D, E* of Fig. 1 show instances of localized buckling. How much influence this had on the strength of the columns is not known, as no local failure was observed until long after passing the ultimate strength. The tables of results indicate, however, that such influence was negligible.

The bodily buckling and the absence of local weakness demonstrated that the columns secured the full efficiency

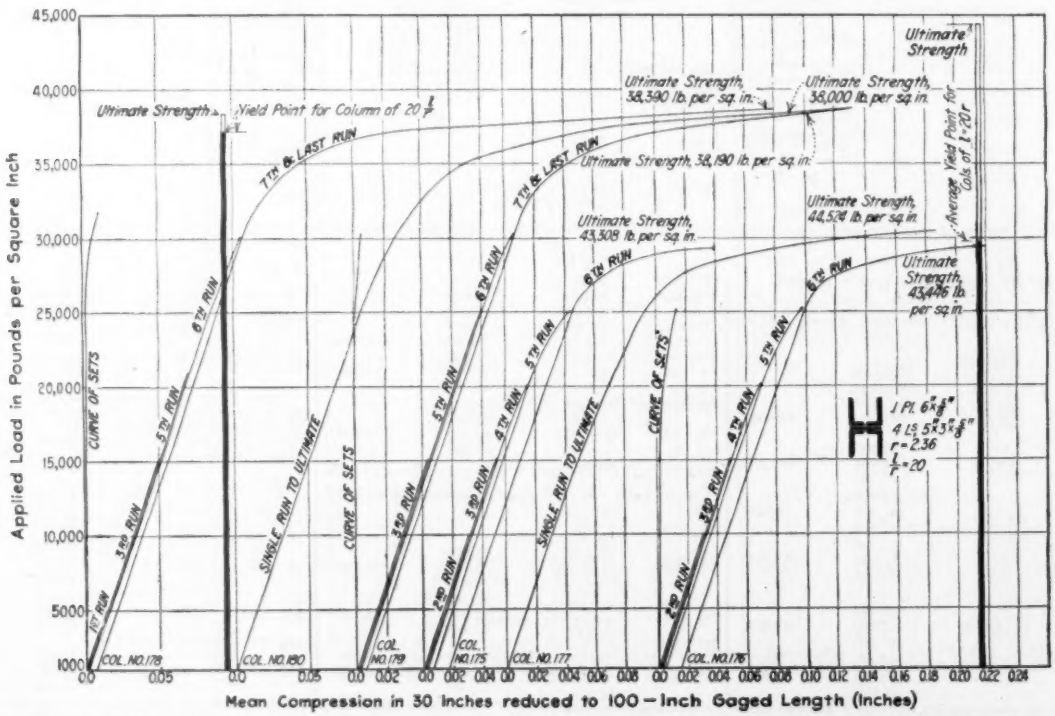

Applied Load in Pounds per Square Inch
Mean Compression in 30 Inches reduced to 100 — Inch Gaged Length (Inches)
Ultimate Strength
Yield Point for Column of 20 r
Ultimate Strength, 38,390 lb. per sq. in.
Ultimate Strength, 38,000 lb. per sq. in.
Ultimate Strength, 38,190 lb. per sq. in.
Ultimate Strength, 43,308 lb. per sq. in.
Ultimate Strength, 44,504 lb. per sq. in.
Ultimate Strength, 43,446 lb. per sq. in.
Average Yield Point for Cols. of l÷20r
7TH & LAST RUN
6TH RUN
5TH RUN
4TH RUN
3RD RUN
2ND RUN
1ST RUN
CURVE OF SETS
SINGLE RUN TO ULTIMATE
COL. NO. 178
COL. NO. 180
COL. NO. 179
COL. NO. 175
COL. NO. 177
COL. NO. 176
1 Pl. 6"×⅜"
4 Ls. 5"×3½"×⅜"
r = 2.36
l/r = 20

FIG. 5. IN SHORT-BLOCK TESTS, LIGHT AND HEAVY SECTIONS SHOW SIMILAR ELASTIC BEHAVIOR, BUT HEAVY COLUMNS SQUEEZE WITHOUT BUCKLING AFTER YIELD-POINT IS PASSED

of the metal in the columns. Nevertheless, large differences of ultimate strength were found between similar columns. In nearly all cases two columns of similar make-up but of different thicknesses of metal, that is one column of thin and the other of thick metal, showed decidedly lower strength for the columns of thicker material.

No reason for this difference can be discovered in the mill tension tests of small specimens, as all these fall fairly well within the ordered yield-point range, 37,000 to 39,000 lb. per sq.in. Compression tests in progress on entire sections of channels, I-beams and other shapes, some of which have already been completed, show that the compressive strength of the metal in different columns is not at all the same. Some of the metal has an average compressive yield-point well below 30,000 lb. per sq.in., other pieces as high as 42,000. In addition, the short-block tests—i.e. those made on columns of total length equal to 20 r, or pin-end length-ratio 10—exhibit directly the compressive quality of the metal and plainly show the variations in compressive yield-point.

It has long been known that the strength of a column is limited by the compressive yield-point of the material; the present tests, so far as they apply to this point, are wholly confirmatory. Since the tests show that different lots of steel ordered to the same tensile strength and tensile yield-point may have widely different compressive yield-points, they demonstrate that steel columns supposedly alike may differ in strength by 25% or more. How this unsatisfactory condition may be cured and how metal of high compressive quality is to be obtained from steel mills under regular commercial conditions is a matter for early consideration.

Summary of Important Results

The value of the tests is pretty fully embodied in the two extensive tables of ultimate strengths which we have compiled from the Bureau's test sheets. Reading these tables in conjunction with the column drawings, Figs. 2 and 3, various facts become apparent. We give in the following those that appear to have the chief practical importance:

Columns whose component elements are connected by tie-plates are much weaker than those in which proper latticing is used. Tie-plate connection should not be used, therefore.

Well-built latticed columns and columns of solid cross-section can readily be made free of all local weakness, so that they will fail by integral buckling.

When a column fails by integral buckling, the limiting factor of strength is the compressive yield-point of its metal. The higher the compressive yield-point of the metal, the stronger will be the column.

Columns whose length-ratio is 25 or less (pin-end basis) have an ultimate strength equal to or just below the yield-point of the metal. For greater length there is a progressive decrease in strength, fairly well expressed by any of the ordinary column formulas. Even up to length-ratio 72½ the influence of the yield-point of the metal is still distinct, that is, the conditions expressed by the Euler formula are not nearly approached.

A good column shows a straight stress-strain curve (Fig. 6), which bends quite sharply to failure. Thus, practically the entire ultimate strength of the column is to be regarded as "available strength" for purposes of design. For a given working stress, therefore, the factors of safety possessed by two columns will be in the same ratio as their failure-strength in test.

The columns of ½-in. to ⅝-in. material show considerably lower strength in most cases than those of ⅜-in. material. The reason for the lower strength lies in the lower compressive qualities of the thick rolled material.

Specifying the tensile strength and tensile yield-point will not fix or guarantee the compressive yield-point, even though a rather high tensile yield-point be called for.

Attempts To Eliminate Dangerous Railroad Crossings

California Commission Recommends 1100 Improvements To Lessen Fatalities and Injuries to Users of Highways

IN CALIFORNIA the state railroad commission has exclusive jurisdiction over all grade crossings of highways and railways. Between June 30, 1914, and Dec. 31, 1916, there were 229 persons killed and 896 injured at these crossings, largely through the carelessness of the persons driving on the highways. The commission is now making an examination of every such crossing in the state. If possible, each crossing is examined in the presence of the railroad company's representatives and the local highway authorities who are interested in it. The commission makes a report on each crossing, sometimes giving recommendations for improving the existing conditions. The recommendations are usually confined to improvements that do not involve the separation of the grades of the highway and railway, for such elimination of grade crossings is too expensive where the hazard is slight.

The recommendation made most often is to place, change or remove signs at these crossings; the recommendation coming next in frequency is to cut down brush or trees or to trim trees that interfere with the view of the tracks from the roads. Out of 1100 recommendations for the improvement of grade crossings, 768 were of one or the other of these two classes. In 92 cases the commission advised closing the crossing, because to do so would cause little inconvenience and greatly reduce the dangerous conditions. In 66 cases the installation of automatic flagmen or bells that give warning of the proximity of the train to the crossing was recommended.

No Warning Signal Is Certain

Like all warning signals, however, none of these are a certain check to the careless driver, and for this reason some road builders believe in reviving the "bump" used a number of years ago to stop reckless speeding. This is merely a transverse ridge, which a car moving at a moderate speed will pass over without other results than a slight jar; a car moving at high speed, however, will receive such a jolt that the driver will be cautioned of danger. These "bumps" it is proposed to place near the warning signal, so that every car will be brought under control before the crossing is reached, provided the driver is careful and intelligent.

In 30 cases the commission recommended the removal of billboards, buildings and other obstructions to a view

of the tracks. An unnecessary hardship to the large number of careful drivers results from the presence of such obstacles to the oversight of tracks leading to the crossing.

If the billboards served any public purpose, there might be some excuse for locating them in such places. The buildings often belong to the railway company, which has a tendency to place tool sheds, store sheds and other small structures near the tracks at crossings where they cause the traffic on the highways the maximum inconvenience. It is strange that this is so, in view of the fact that every grade-crossing accident costs the railway on which it occurs a sum that would remove many of these sheds to more suitable positions.

In 27 cases the commission recommended that the highway approaches to the crossing should be graded, in four cases it advised changing the alignment of the highway, in 14 cases it advised grading between rails, and in one case it advised changing the location of the crossing. In only 18 out of the 1100 cases did it recommend the separation of the grades of the highway and railway. This last fact is significant of the change in public sentiment regarding grade crossings in the last 15 years. At one time there was a quite general demand that grade crossings should be removed at the expense of the railroad companies everywhere, without regard to the fact that probably no railroad company could do so without going into bankruptcy. That only 18 out of 1100 grade crossings are now considered to require a separation of grades indicates a more complete understanding of the real causes of danger at such places and of the means of reducing it to a negligible minimum.

Canadian Cantonments All Built by One Contractor

Organization Developed During Three Years of Rush Work Completes Camps in Short Order

ALL OF the military camps built in Canada in the past three years have been the work of one contractor, Bate & McMahon, of Ottawa, and have been put up under the direction of Col. Robert S. Low, manager of the firm, who was early in the war commissioned a colonel to facilitate the military control of the construction. While none of the camps has as many buildings as are designed for the new United States cantonments, two of the Canadian camps, Borden and Valcartier, have housed as many or more men under canvas and have required equally elaborate and extensive sanitary services and auxiliary buildings. Most of the other work in Canada has been the construction of aviation camps to quarter from 1200 to 1500 men and a great amount of aviation equipment. All the camps were rush jobs, and from the beginning Colonel Low has specialized on speed, so that today he has under his charge a unique organization of remarkable experience in hurry-up work.

An important and distinctive feature of the organization is its mobility. From the early days of the war, when Colonel Low caught his workmen early in the morning of Aug. 5, 1914, on their way to another job and dispatched them immediately by train to the site of the Valcartier camp at Quebec, the complete organization, men, equipment, and food, has been on call for dispatch to one after another of the camps which have been ordered by the military direction.

The second important factor in the speed is that the whole organization is self-contained. The full layout of contractor's equipment, comprising motor trucks for delivery, the usual quota of steam shovels, ditchers, backfillers, concrete mixers, derricks, engines, and minor tools have been so selected that they can be loaded onto a train and sent wherever required. Attached to this same train or to others closely following it are the cars carrying the men and provisions sufficient to last three weeks, so that on whatever site they are started, work can be carried on for that length of time before call upon local stores or upon local delivery must be made.

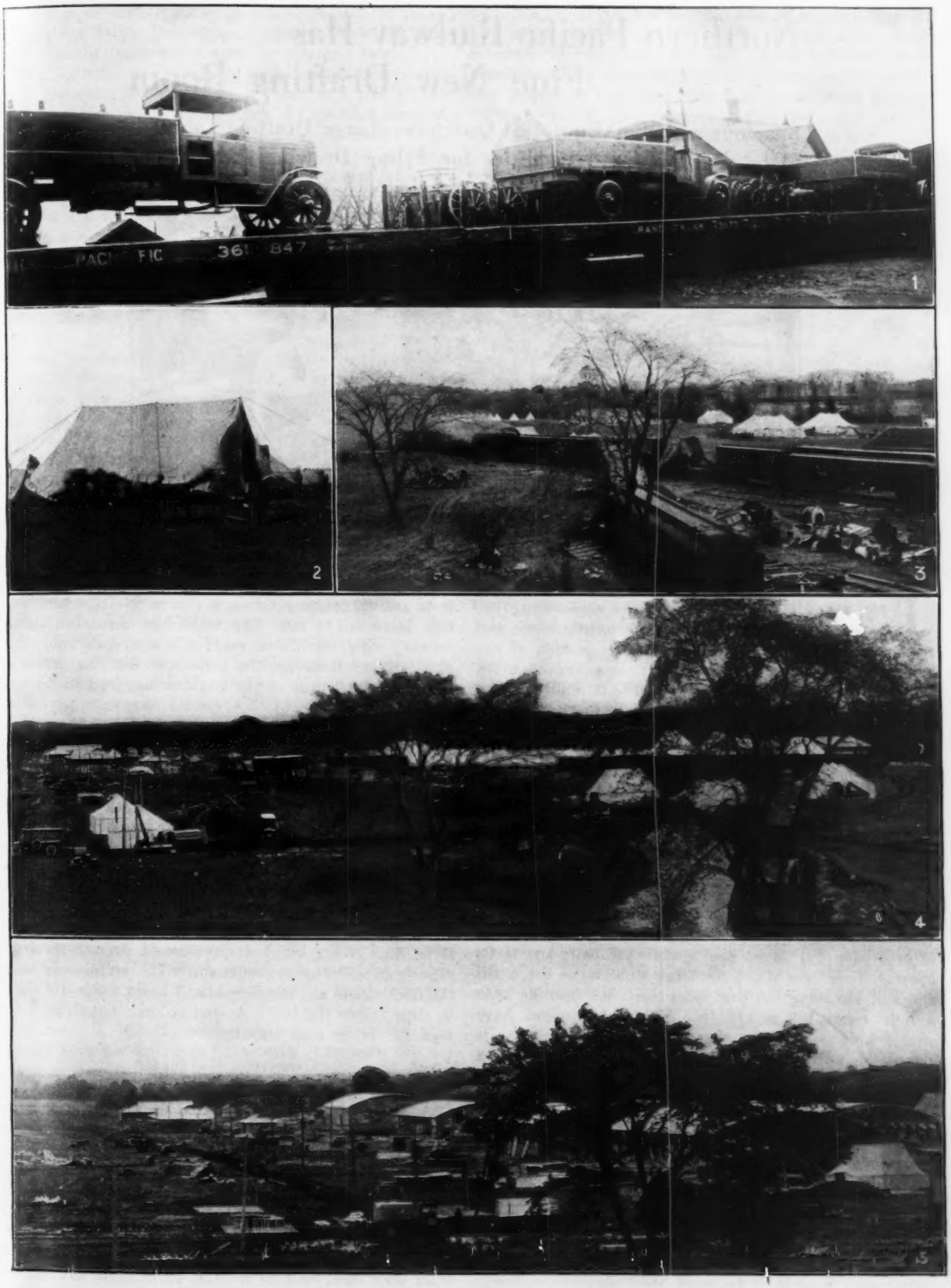
Equipment Loaded on Cars

Some of the accompanying views show typical camp work. The first one shows some of the cars loaded with the contractor's equipment. These cars are brought as near as possible to the camp site and tracks are then immediately laid to the site proper. When the site has been reached, old-fashioned circus methods soon run up a tent camp, a typical one of which is shown in another of the views. In this camp 1000 to 3000 workmen are housed. Immediately wells are sunk, telegraph, telephone, and where possible, power connections established, and the preliminary clearing started. Portable sawmills follow behind the timber operations and soon transform the trees into lumber used in the camp construction. Trench diggers follow the clearing for draining the ground where necessary, and in all cases for making the trenches in which the sewer and water pipes are laid. Material, that is cement and aggregate for concrete floors and cement-gun covered walls where such are used, floor frames, sashes, sanitary fixtures, etc., all follow as soon as possible by train. Then building operations are begun.

Rapid Progress Made at Camp Leaside

Three of the views here show the rapid progress made on the most recent of the aviation camps, that known as Camp Leaside, in Toronto. The contractors did not reach this site until May 23 of this year. The first view shows them late in the afternoon of the first day they entered, and the trains carrying their men and equipment in the foreground and the tents for the construction force already in place. The other two views show the progress at the end of one week and at the end of three weeks. The work here comprised not only considerable clearing of rough timber but the drainage of the aviation field, the erection of houses for quartering the men, and the construction of a number of large-size hangars, together with the necessary roads and wiring connections. Most of the buildings of this type are of wood frame, sheathed on the side with 2-ply roofing, and on the roof with 3-ply.

All of this work is done under the general direction of the military organization of Canada. The design details are, however, left mostly to the contractor. He is told how many men are to be housed in the camp and given specific instructions, of course, as to the number and general design of the many buildings. His own design force then proceeds to the work under the general direction of a military officer. Contracts are let on a cost plus fixed sum basis, the government keeping the only time that is used on the work and the government also checking the contractor on his bill of material.



RUSH WORK IN BUILDING AN AVIATION CAMP, CAMP SEASIDE, ONTARIO

1—Construction equipment loaded on train to ship to camp. 2—Canvasmen putting up the workmen's tents. 3—The camp site at the end of the first day on the job, May 23. 4—Railway sidings in, material dumped and some buildings started one week later, June 1. 5—Hangars well along and quarters nearly complete. Three weeks after reaching camp, June 15

Northern Pacific Railway Has Fine New Drafting Room

Spacious and Well-Equipped Quarters—Large Drafting Tables—Metal Filing Cases—Facilities for Filing Drawings and Books

THE new office building of the Northern Pacific Ry. at St. Paul, Minn., has the engineering department on the twelfth and thirteenth floors, and the main drafting room occupies a large portion of the former. It is approximately 117 ft. long and 35 to 58 ft. wide, with an area of nearly 6200 sq.ft. undivided by partitions or interior walls. The height is 11 ft. This room will accommodate 60 to 75 draftsmen and is used by the forces engaged in maintenance, valuation, bridge, map and general work. Separate quarters are provided for the drafting work of the architectural and signal departments. The general layout of the engineering quarters and drafting rooms on the twelfth floor is shown in the plan on p. 650.

Ample Light

Ample light is provided by seven pairs of windows along the east side. The windows are 62 x 89 in., those of each pair only 14 in. apart, while the pairs are 4½ ft. apart. There are also three large windows at the north end and six along the west side, these last opening onto a light court 109 x 146 ft. The east windows have steel double sashes so connected that as the lower one is raised the upper one is lowered. Each window has a "Perennia" folding cloth shade of light buff color. It slides on vertical wires and may be adjusted to cover any desired width at any height, or it may be folded up at the top or bottom of the window. There are 76 lamps of 100 watts each, suspended from the ceiling and concealed by bottom bowl reflectors in order to give indirect, or diffused, lighting.

The record engineer, with his clerical force, occupies a space about 22 x 42 ft., shut off from the main part of the room by the large steel filing cases required for his voluminous records. An open steel stairway connects this space with the thirteenth floor, which is occupied by the valuation engineer and his force.

Ranged along the outer (east) wall and at right angles to it are 31 drafting tables, all 42 x 84 in., except one that is 58 x 144 in. The tables are boards on trestle frames, with small drawers for instruments and supplies. Near them are the desks and drafting tables of the chief draftsmen of the engineering department and the bridge department. A special feature is an Ulrich shadowless, or transparent, drafting table 3½ x 7½ ft. It has a ground-glass top over a chamber containing electric lights and is used particularly for tracing old and faded drawings and maps. It was built especially by the Wausau Fixture and Furniture Company.

The inner part of the room has several filing cases, mostly of steel. These cases have drawers and shelves, the shelf space being either open or fitted with doors. Bridge plans are filed vertically in two steel cases mounted on wheels and having hinged tops or lids. The tracings are placed between fiber sheets arranged in "accordion" style, thus giving sufficient pressure to prevent the tracings from slipping or buckling. The sections between the fiber sheets are numbered, and index cards are fitted to clips inside the lid. A similar case, 62 x 31 in., is used for filing map tracings.

Cases for Materials

A metal case, 3½ x 7 ft., and 40 in. high, with doors, has compartments for storing opened rolls of tracing cloth, profile and detail paper, cross-section paper (in sheets and rolls) and stationery supplies. Beneath the top is a recess having an iron rod, in brackets, carrying the roll of detail paper that is in use. A wood case, 28 x 30 in., 4 ft. high, with locked doors, is provided for keeping pencils, pens, erasers, brushes, inks, water colors, etc. Upon it is mounted a Boston pencil pointer. Another wood case, 50 x 30 in., and 40 in. high, has shallow drawers for stationery and other supplies. A general-utility table, 4 x 15 ft., has drawers of various sizes for

the storage of such supplies as unopened rolls of paper and tracing cloth, jars of paste, large bottles of ink, safety gasoline cans and waste, for cleaning tracings.

Printing titles on tracings of maps and profiles (mainly for the valuation engineer) is done by a No. 9 "Official" printing press, which, with a type case containing 16 fonts of different sizes of type, is mounted on the general-utility table. The press is also used for printing small blank forms. For the tracings, ordinary printers' ink is used. While this practice necessitates allowing time for the ink to dry, it is found that quick-drying inks do not penetrate and therefore gradually rub off, so that good blueprints cannot be made.

Two Sets of Railway Curves

Two sets of Stowell Bros. metallic railway curves are kept in the top drawer of one of the cases, being ranged in order by degree or curve, with labels pasted on the bottom of the drawer. Holes in the curves allow placing them over upright brads that are driven into the bottom of the drawer and thus hold the sets of curves in place. This method of keeping the curves was adopted for the reason that driving nails in the walls is prohibited throughout the building. Where pictures, maps, clocks, time cards, etc., are required, they must be suspended from hooks on the picture molding. The draftsmen have their own instruments, which with T-squares, triangles, etc., are kept on the tables or in small drawers beneath them.

Several white porcelain washbowls are provided, each having hot- and cold-water taps and a third tap for cooled drinking water. There is also a large inclosed sink that can be used by the draftsmen for washing glasses, bottles and other articles. All waste-baskets are of noninflammable fiber. For coats and hats there is a portable rack at one side of the room. The railway company provides individual drinking glasses and supplies each man with two towels per week.

Blueprinting Equipment

The blueprinting room, 24 x 37½ ft., is on the thirteenth floor (top). It is equipped with a Pease automatic electric machine, with its washing and drying apparatus. The finished prints are automatically wound up in a loose roll. This machine takes paper 54 in. wide. For trimming prints there is a 45-in. shear, having a graduated platform 3 x 4 ft. There are also four tables, two of which are large trimming tables, 5 x 12 ft. and 3½ x 10 ft., with 2½-in. wood tops and iron-pipe legs.

A case 3 x 16½ ft., behind the machine, serves as a general table for laying out the work. Beneath the top are open and closed compartments for storing blueprint paper and the tracings that are in use. With this equipment, an operator and two assistants do all the work for the engineering, mechanical and right-of-way departments. During the year 1916 about 854,000 sq.ft. of blueprint paper was used, besides large quantities of white and negative papers. Comparatively little use is made of white prints, owing to the extra time and cost of making the negatives.

Vault and Filing Equipment

For the storage of drawings and records, there is a fireproof vault 24 x 37½ ft., 11 ft. high, on the drafting-room floor. It has the unusual feature of being lighted by a large window. This is on the court side (the only exterior wall) and has metal sash frames with wire-glass panels. There are also 12 ceiling lamps of 60 watts. For drawings, there are four filing cases with pigeonholes above and drawers below. Five cases with shelves only are provided for fieldbooks and similar records. All these cases, with a table, are of steel, the only wood equipment being a wheeled step-ladder. The steel filing equipment in the vault and drafting room is of the Art Metal Co.'s manufacture.

One of the filing cases for drawings occupies an entire wall of the vault, being 37½ ft. long and 11 ft. high with a depth of 31 in. The upper part has 374 pigeonholes or compartments, 7¼ in. high and 12¾ in. wide, while the lower part has several tiers of drawers. A double-faced case, 15 ft. wide, 11 ft. high, and 11½ in. deep on each side, has 460 pigeonholes 4⅝ x 12¼ in., used mainly for rolls of profiles. Beneath are 16 drawers 9 in. deep, 14 x 22½ in. They are for various groups of sketch plans and track-mileage records. This case also has metal boxes in which are filed track profiles (1 in. = 400 ft.), condensed profiles and rail charts. The fourth case is 8 ft. 9 in. wide, 10 ft. high and 35 in. deep, used mainly for station plans and maps.

For the fieldbooks, there are four double-faced cases 10 ft. long, 11 ft. high and 12 in. deep, and one case only 6 in. deep. These cases already contain over 15,000 fieldbooks, dating from 1864, and have room for many thousands more. The books have numbered labels pasted on the back.

Diagram of Filing Layout

A diagram of the layout is placed in the vault to facilitate the location of required compartments or drawers, but the taking out and replacing of files are supposed to be done generally by the filing clerk or his assistant. On the inside of the vault door, and therefore conspicuous when the door is open, is a clip board with a renewable white-print sheet for recording files taken from the vault. This sheet is ruled in columns for files of seven different classes—plans, maps, fieldbooks, etc.

When a file is taken out, its number is marked in the proper column; and in another column is entered the name of the person who takes the file or to whom it is given. The entries are canceled when the files are returned. This method places responsibility and often saves time and trouble in searching for missing files.

Filing and Indexing System

The filing clerk and one assistant care for all the drawings, fieldbooks, etc., filed in the vault. These clerks have a space about 22 x 15 ft. in the drafting room, equipped with tables. The main file is a "Globe" card-index cabinet with cards 5 x 8 in. The cards are of five colors: White for maps, pink for profiles, buff for structures, blue for bridges, and green for statements and statistical tables. They are filled out on a typewriter. There are also individual index books for special classes of records, such as stations, etc.

Bridge, building and other structural plans are filed flat in shallow drawers of suitable size. Each drawer has a fixed cover at the rear to keep plans from slipping out, and a hinged flap at the front to rest on the

plans and hold them in place, so that they will not be damaged in pulling the drawers in and out.

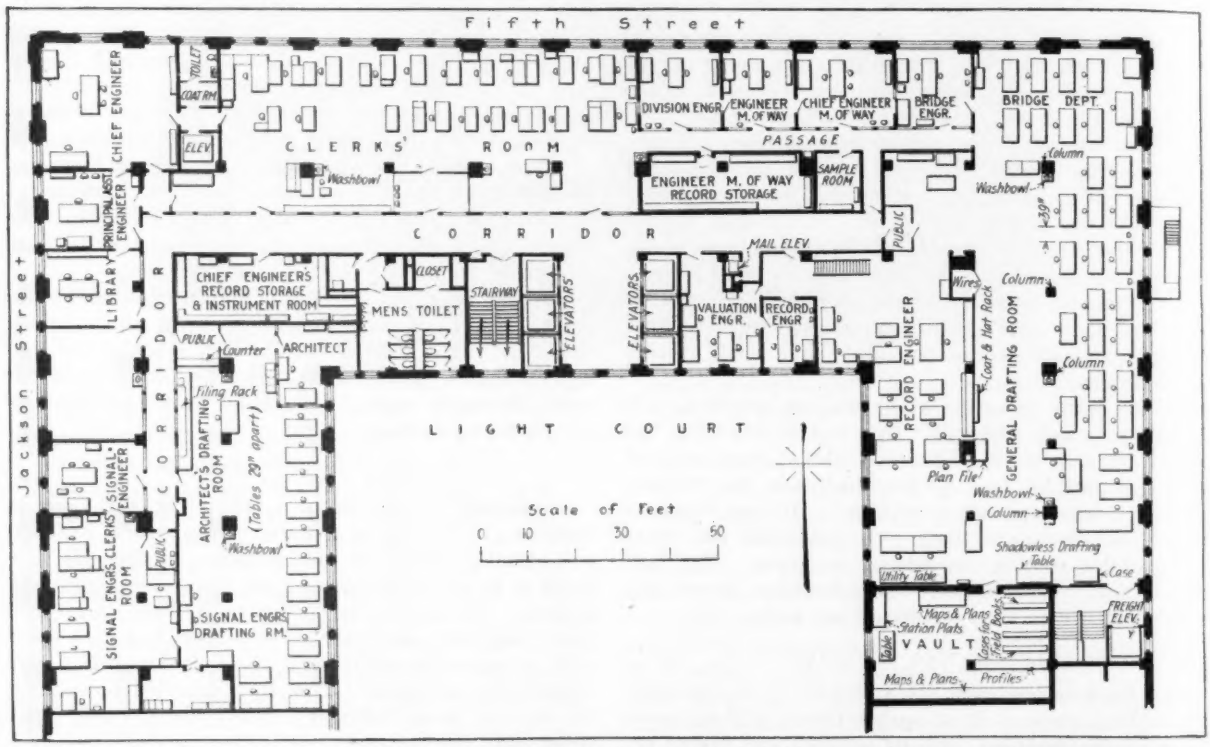
Station and other plans, and maps of all kinds, are rolled on strong cardboard tubes and kept in large pigeonholes or compartments. The tubes are 1¼ in. in diameter, with closed ends, and each has attached to it a paper flap that rolls up with the tracing or drawing. A rubber band is placed over each roll. The tubes are of three lengths: 30 in., 34 in. and 42 in. Those in any one file case are the same length, which is a little less than the depth of the case.

On the fixed cap at each end of the tube is a white disk with red border and horizontal red line. In the upper part is printed (by hand) the number of the compartment. In the lower part is the individual file number, each compartment having its own series of numbers up to its cubical capacity. Thus, after looking up the card index, it is a matter of a few moments to locate the compartment and then to find the roll of the desired number in that compartment.

With this arrangement it is not necessary to label the compartments. The drawers, however, have labels of white cardboard in bronze frame plates. Drawers containing files not referred to in the card index have brief inscriptions to indicate the contents. All files have printed across the end the number of the drawer or compartment and the individual number.

An exception to the above arrangement is made in the filing of station plans, in order to retain a system adopted several years ago and to avoid the trouble of converting all these old file numbers. In this case each vertical row of compartments has a letter and each compartment of that row has a number: A-1 (at the top), A-2, B-1, etc. Each tube is marked with the letter and number of its compartment and also with the name of the station or spur represented on the plan. These plans, on a scale of 100 ft. to the inch, are filed by sections of the main line and by branches, without alphabetical arrangement.

The plans of a large station layout may be in two to four parts, rolled on one tube. For the large terminal stations, such as St. Paul, Seattle, etc., with six to thirty sections, there is a separate tube for each section. To locate the sections, there is a blueprint index map for each of these terminals, rolled on a tube having a pink label marked Index and filed in the same compartment. Rail charts are being made for each station, showing the location and length of rails of various weights. These



PLAN OF ENGINEERING DEPARTMENT AND DRAFTING ROOMS IN THE OFFICE BUILDING OF THE NORTHERN PACIFIC RY., AT ST. PAUL, MINN.

charts are rolled on the same tubes as the station plans, a blue line being marked across the label, at right angles to the red line, to indicate stations having the rail charts.

The filing case for station plans is 8 ft. 9 in. wide, 10 ft. high and 35 in. deep. It has 99 pigeonholes 6 in. high and 10 in. wide, also large and small drawers 3½ in. deep. In one of the large drawers are kept, on labeled tubes, maps 22 x 36 in., on a scale of 1 in. = 4 miles, covering the entire Northern Pacific Ry. and its connections. There are also separate sheets (on a larger scale) of plans of the more important towns. As there are 50 of these sheets, each tube carries two sheets, the cap labels showing the number of the sheet for the general plan, or the name of the town for the detail plan. Other drawers contain state, county and city atlases.

In drawers 14 x 22½ in., and 9 in. deep, are filed vertically the "A.F.E." (authority for expenditure) sketches. They are tracings 8 in. wide and of necessary length, showing proposed changes or improvements. Blue-

prints of these sketches are used in various ways. Letter-filing cases in one of the compartments contain sheets, 8½ x 12⅜ in., of sketches and plans of grade crossings, etc.

All work passes through the hands of the chief draftsman of the engineering department, except that matters relating to bridges and culverts are attended to by the chief draftsman of the bridge department. The work under the former includes not only the preparation of plans, maps and drawings for new work and improvements, but also the keeping up of road charts (for rails, ballast, etc.), progress profiles and records received from the record engineer, who has his quarters and files in the drafting room. It covers also the map and work for the valuation now being done for the Interstate Commerce Commission, eight of the draftsmen being at present assigned to this work. It may be noted that the conventional signs recommended by the American Railway Engineering Association in its *Manual* are used on all new plans.

The heads of the drafting office and record work are J. N. Pariseau, chief draftsman of the engineering department; R. R. Brockway, chief draftsman of the bridge department; and H. M. Stout, record engineer. All —work is under the direction of H. E. Stevens, chief engineer of the Northern Pacific Railway.

Labor Conditions and How Contractors See Them

Shortage of Supply and Shifting of Men from Place to Place Constitute Difficult Problem and Chief Cause of Decreasing Efficiency

THE contractor or the construction engineer with work to be done and a time limit or penalty looming in the distance is sure to find increasing trouble in regard to the supply of men, judging from opinions expressed to this journal by leaders in the railway and construction fields. The labor problem was discussed briefly in *Engineering News-Record* of Apr. 26, and information was given in detail as to the experience on one large railway job. A rather wide inquiry made since that date, as to opinions and experience, indicates that the condition is recognized as increasingly serious. This is due not only to the actual shortage of supply, but to the great loss of time, money and energy consequent upon the unreliable character of a large proportion of the common-labor element.

Foreign Labor Travels in Gangs

Foreigners are still fairly plentiful. They are handled usually in gangs headed by interpreters, especially in the case of men from the countries of southern Europe. While the men usually stick together in their gangs, it is uncertain how long a gang will stay on the job, even after it has started to work, since for any grievance or any advantage elsewhere the interpreter is apt to take the gang away at short notice. Some railways, however, have found that foreign laborers in general are not inclined to shift; and if treated well one season, they are likely to return.

One method of checking the tendency of these gangs to float from job to job on railway work is for the railway to decline to employ men coming from other roads in the same vicinity. Otherwise, the leaders of the gangs are inclined to play one road against another. They will tell the officials on the road for which they are working that they have been offered higher pay by another road and will tell the officials of the latter that they will come to work for a certain rate of pay. It is usually desirable, or even necessary, to keep the various nationalities and the various grades of labor separate, both in camp and on the work. This is particularly the case at the present time, with war and racial feelings aroused.

With laborers, native and foreign, who work singly and not in gangs, one great trouble is their uncontrollable restlessness. This results not only in making the problem of labor supply continuous, but in making it difficult to organize gangs for work or to keep men who understand the work. On some Chicago track-elevation work done by a railway company, almost 2870 men were employed during a period of six months to maintain a working force of about 400. The average time spent on the work was less than five days for each man. On a 10-mile highway contract, over 5000 men are said to have been employed during the working season of 1916. Drink is of course one of the main causes of restlessness and trouble, but sheer restlessness in itself is a strong factor in the problem.

Many Men Never Even Reach the Job

Another source of trouble is that a considerable percentage of men shipped by employment agencies do not even reach the job, and of those who do reach it only a certain proportion actually go to work. As a means of checking the wandering tendencies of the men it has been suggested that local communities and their officials should coöperate with the railways to prevent men from beating their way on freight trains. This is a large subject that has been discussed for years, but it seems almost impossible to secure the coöperation of local bodies for this purpose.

The Southern railways have had an ample supply of negro labor along their lines, but are now facing a marked change in this condition, due to the extensive movement of negroes to northern sections, as a result of the great inducements offered for work in industrial plants. The railways are trying to meet this situation by increasing the wages, paying the men more frequently and furnishing boarding-camp and boarding-car outfits. In the Southwest, where Mexican labor has been largely employed, the troubles on the border have led to a decrease in the quantity and reliability of this class of labor. In the Northwest, the Japanese labor is fairly plentiful on the railways.

With the common laborers employed singly, as distinguished from those employed in gangs, some distinction should be made between the "hobo" and the "tramp," though the dividing line is not sharp. The hobo is a good worker, but peculiar in his ways. He does not seem to care for regular employment, but after working long

enough to earn some money he wants to have an opportunity to spend it and then moves on to another job. He is likely to have intelligence, but is not endowed with staying capacity. The majority of hobos are Americans, or men from northern Europe who have been in this country long enough to know its ways. They get their jobs largely through labor agencies.

The Tramp Does Not Want Work

The tramp proper does not want to work, even to earn something to spend. He prefers to get his money in some easier way and takes a job only in emergency and with no intention of sticking to it. He is less cleanly and less reliable than the hobo and usually drifts into the work casually instead of being sent by a labor agent. One contracting firm states that on a job in Ohio its common laborers were mainly "American bums, who were either drunkards or petty criminals."

One peculiarity of the situation is the difference in living accommodations required by men of different nationalities. As an instance, B. M. Cheney, general inspector of permanent way and structures on the Chicago, Burlington & Quincy R.R., states that most foreign labor prefers wooden bunks, while the hobo, negro and Mexican prefer steel bunks. But this is not all; different nationalities have their own preferences in bunks, and the Greek is not satisfied with the kind of bunk built by the Italian. For this reason, in furnishing cars for foreign laborers this road supplies the lumber and lets the men build the bunks in accordance with their own ideas.

What Contractors Say

Inquiry as to individual experience and practice brings out interesting information, some of which is condensed below:

Morris, Shepard & Dougherty, of St. Paul, emphasize the fact that the time of service given by common labor for the last couple of years has been very unsteady. Outside of the employees who have been working more or less steadily among subcontractors, laborers do not remain much over a month before they move on to some other job. There is no special reason why they should quit, except their restless condition.

The nationalities employed in this section are largely Swedes and Norwegians. Previous to the opening of the war, there were some Austrians and Italians, but very few of these are to be had at the present time. The contractors in this section have been endeavoring to improve the housing and feeding of the men and have increased the wages as an inducement for them to remain on the various jobs, but it seems to have little or no effect.

Laborers Average Less Than a Month on the Job

Winston Brothers Co., of Minneapolis, finds that common laborers average less than a month on the job. They enjoy change and therefore move on, being sure of a job whenever they want one. Hobos of all nationalities are employed. Gangs of Austrians, Hungarians and Slavs stay the longest. Men may be encouraged to stay by a bonus system, with extra pay for a definite period of 60 or 90 days, or to the end of the job.

P. T. Clifford & Son, of Valparaiso, Ind., also find it hard to keep common or transient labor. Good board and sleeping quarters, with prompt and frequent payment, are thought to furnish the best general solution of the problem. This applies also to foreign labor. Italians and Rumanians are being employed, and there is no great difficulty in securing all the men required.

The Dravo Contracting Co., of Pittsburgh, finds that the majority of common laborers in that section render efficient service for four or five days, when they become dominated with the craving for intoxicants. The resulting loss of interest in the work necessitates prompt discharge. The men get drunk, perhaps have a term in jail and then go to work for a few days with some other outfit. The company has sanitary camps and messhouses, with good food and beds, heat, light, running water, modern toilets and shower baths. Every possible means is taken to prevent the use of intoxicants.

With Higher Wages, It Takes Less Time To Get a "Stake"

The Bates & Rogers Construction Co., of Chicago, reports that, in general, the length of service is merely long enough to get a "stake" of $10 or $12. As wages are increased, the length of stay is shorter. The main reason for leaving the jobs is that the men have made money enough to go and "blow it in." The men are largely Italians, Greeks, Rumanians and Austrians.

This firm has tried the bonus system for holding men on jobs. The man is hired with a definite understanding that if he stays a certain period of time, say 60 or 90 days, or until the job is finished, he will be given an increased rate or bonus. This has not given much satisfaction, however. Some good resulted from making the camps as attractive as possible, including good food and good sleeping accommodations. At one of the larger jobs it is proposed to have a Y. M. C. A. outfit, similar to that established with the troops, including a phonograph, moving-picture machine, writing facilities, games, etc.

One Contractor Discusses the Question in Detail

Charles Ffolliott, president of A. Guthrie & Co., contractors and engineers of St. Paul, discusses the situation at length. His opinion follows in his own words:

"The matter of the transient character of common labor is a very interesting one to contractors, and one which has puzzled them for a considerable length of time. It is hard to understand why a man will make a most uncomfortable journey on a railway for two days moving to a job, when he has arrived at his destination stay only for a few hours or a few days and then walk off. It may be said that the men do this just to get transportation to some point to which they want to travel. No doubt this is done in many instances; these men, like many others, have no compunction in beating the railways. Most of the men, however, have no particular place in mind. They just go because they want to move and can move without cost. If they arrive in the evening, they get supper, bed and breakfast, so they figure they are that much ahead and are beating somebody—which seems to them a very proper thing to do.

"The time of service given by the common laborers on any job varies a great deal according to the individual. Among our outfits there are always a few men who stay the entire time of the job. These are men who have worked for us a number of years and can generally be relied on as steady men. But the great proportion of common laborers, especially in harvest time, do not stay longer on an average than four or five days. This refers

mostly to the 'white' men. Where 'foreign' gangs are employed, the term of service is very much longer. In fact, a good 'foreign' gang can be relied on to stay as long as their interpreter does not find a better job for his gang.

"These foreign gangs almost always insist on having their own quarters, boarding cars or camps and buy their own provisions and board themselves, the contractor in most cases paying for the cook. This boarding of the men by themselves tends to unsanitary conditions and to poorer food being used than if the men boarded in a good contractor's camp."

Temptation to Nomadic Habits

In Mr. Ffolliott's opinion the great body of "white" nomadic labor that wanders about the country from place to place, remaining a day or two on any job or long enough to get a little money to go to town with, constitutes the chief problem. The facility with which these men can move from place to place is mostly responsible for their wanderings. When work is plentiful, they can go to any labor center, hire out at an employment agency and secure free transportation to the different jobs. If they cannot get shipped by an employment agent, they can go down to the railway yards and board freight trains to almost anywhere they wish, if they have any money to pass to the trainmen for their transportation. The trainmen will accept almost anything that they can "shake down" from these laborers.

"As long as this state of affairs exists on the railways," continues Mr. Ffolliott, "we will have this vast horde of nomads traveling over the country from place to place and doing very little work. If the authorities in the different states would prevent this illegal traveling, the supply of labor would be increased and the tramp element, which is a great menace to the country, would be largely eliminated.

Why the Men Leave Work

"The reasons for a man quitting a job and going to another place are numerous. The camps may be uncomfortable. The board may not be good. The different camps are discussed among the laborers, and they know where the better camps are, where the contractors are who have the reputation of keeping good camps. A great deal has been done by contractors lately in improving the condition of laborers in the camps, providing better sleeping quarters, better dining rooms and better-cooked food.

"The climate also has its influence on the wanderer. The laborer will leave the Northwest as soon as the cold weather commences and travel south. It saves clothes. Again, as soon as the warm weather commences, he will leave the South and travel north. The ease with which he can get transportation, as explained above, facilitates this movement. Most of these laborers have no family ties and no stated home and get into the habit of traveling—a habit which is very hard to break.

"The men employed are of many nationalities. There is a great army of common laborers of various nationalities known as 'white' which seems to have no family or other ties and travels all over the country. Then there are the laborers from central Europe, who generally travel in gangs and keep together fairly well. Of late years there has been a tendency for individuals from the central European gangs to travel about with the native white men or by themselves. The nationalities mostly represented by these foreign gangs are Austrians, Greeks, Bulgarians, Montenegrins and Italians. These gangs are not nearly as numerous as they were before the war, and the war is largely responsible for the great scarcity of labor at the present time.

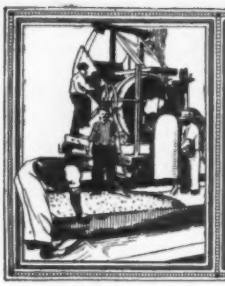
"As to the steps that are being taken by contractors to increase the efficiency and economy of labor and to encourage men to remain on the job, there has been no concerted movement. Individual contractors have done a great deal to improve the condition of their camps, providing proper water closets, baths and heated apartments for housing their men. Of course, these facilities can only be provided on jobs that last for a considerable length of time. In the ordinary railway camp in the country away from towns, it is impossible to have the facilities mentioned. Still, a great deal can be done and is being done by contractors who realize the great importance of having their men comfortable and having them remain with them during the work. But notwithstanding all the improvements, no way has yet been found to prevent the men from traveling from place to place in the manner described, and it is fair to attribute this almost entirely to the ease with which the men can travel on the railways."

Typhoid by States in 1916

Mississippi had the highest and Massachusetts the lowest death rate from typhoid fever of 33 states (including Hawaii and the District of Columbia) in a list for the year 1916 published by the United States Public Health Service. The table, reprinted here, gives evidence of "relatively complete" records for the states of Kansas, Maryland, Massachusetts, Minnesota, Mississippi, Montana, New Jersey, New York, and Washington, and for the District of Columbia, the Public Health Service says, since for these states 7 to 10 cases were reported for each death registered. The next to the last column of the table shows, by the same token, incomplete records for some other states, notably for Alabama, Louisiana, Oregon, Rhode Island and Wisconsin.

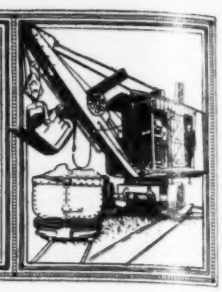
TYPHOID FEVER REPORTED DURING THE CALENDAR YEAR 1916

State	Cases Reported	Deaths Registered	Indicated Case Rate per 1,000 Inhabitants	Indicated Death Rate per 1,000 Inhabitants	Indicated Fatality Rate per 100 Cases	Estimated Population July 1, 1916
Alabama	3,591	694	1.540	0.298	19.33	2,332,608
Arizona	51	...	0.200	...	...	255,544
California	1,205	209	0.410	0.071	17.34	2,938,654
Colorado	542	...	0.563	...	...	962,060
Connecticut	538	93	0.432	0.075	17.29	1,244,479
District of Columbia	308	46	0.846	0.126	12.50	363,980
Hawaii	212	44	0.983	0.204	20.75	215,741
Indiana	3,296	600	1.170	0.213	18.20	2,816,817
Iowa	...	155	...	0.070	...	2,220,321
Kansas	2,104	263	1.150	0.144	12.50	1,829,545
Kentucky	...	695	...	0.292	...	2,379,639
Louisiana	1,413	347	0.772	0.190	24.56	1,829,130
Maine	426	...	0.551	...	...	772,489
Maryland	2,668	267	1.958	0.196	10.01	1,362,807
Massachusetts	1,515	161	0.407	0.043	10.63	3,719,156
Michigan	2,225	405	0.728	0.133	18.20	3,054,854
Minnesota	916	127	0.402	0.056	13.86	2,279,603
Mississippi	6,035	668	3.092	0.342	11.07	1,951,674
Montana	407	47	0.886	0.102	11.55	459,494
New Jersey	1,390	194	0.472	0.066	13.96	2,948,017
New York	4,417	593	0.430	0.058	13.43	10,273,375
Ohio	4,273	...	0.830	...	...	5,150,356
Oregon	210	52	0.251	0.062	24.76	835,471
Pennsylvania	8,697	...	1.021	...	...	8,522,017
Rhode Island	170	37	0.277	0.060	21.77	614,315
South Carolina	.....	475	.....	0.292	.....	1,625,475
Texas	.....	523	.....	0.118	.....	4,429,566
Vermont	165	24	0.454	0.066	14.55	363,699
Virginia	.....	546	.....	0.249	.....	2,192,019
Washington	615	78	0.401	0.051	12.68	1,534,221
West Virginia	1,469	...	1.060	...	...	1,386,038
Wisconsin	999	173	0.400	0.069	17.32	2,500,350
Wyoming	.....	20	.....	0.111	.....	178,559



HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK



Contracting Firm Invites Visitors To See That They Get Attention

THE PICTURE and legend shown in the photograph make it plain to visitors at one general contractor's office in New York City that the firm will appreciate action on the part of these same visitors calling attention to the remissness of men who are asked for and who do not

Don't Wait-
VISITORS PLEASE NOTICE
If you are not waited on PROMPTLY, please ring this bell. If you do not promptly see the party you wish to see, DO NOT HESITATE to ask for him a SECOND time. While we cannot always see you immediately we want to save YOU as much time as possible.

THIS SIGN IS NO BLUFF—THERE IS A BELL BENEATH IT THAT MAKES A NOISE

respond within a reasonable time, or to possible laxity on the part of its office-boy brigade. The significance of this sign is not lost on callers who have been in the offices of some other general contractors in large cities. The chest of the would-be interviewer who is looking for a subcontract or a job swells with satisfaction as he thinks, "At last, I'm going to get a little attention!"

It is only fair to the Raymond Concrete Pile Co. to add that the hopes raised by the sign are seldom disappointed. The members of the firm have made many friends by living up to it.

The wording of the sign was first used by the Gisholt Co., but the photograph and the arrangement originated with P. D. Case, assistant secretary of the Raymond organization.

Men Die of CO Poisoning, at Camp Built on Cinder Dump

DEATH and serious illness in a construction camp in Ohio have been traced, according to Dr. R. P. Albaugh, director of industrial hygiene in that state, to poisoning from carbon monoxide gas generated in a fire beneath the frozen surface of a cinder dump at a steel plant, where the camp was constructed. The seriousness of the occurrence arose from the fact that the camp was well built and ventilated, and the doctors called to the scene could think of no cause for the illness except ptomaine poisoning. It later developed that such poisoning did not occur, and the food and kitchen conditions at the camp were found to be of the best.

First Evidence of Trouble

The construction gang housed at this camp consisted of about 30 white and 30 colored laborers, with different bunkhouses. About 8:30 on the evening of Dec. 18 last, one of the men discovered a colored waiter lying unconscious on the floor of the bunkhouse, having apparently fallen from the second-tier bunk that he had occupied. The superintendent was notified, and with several others attempted to revive the negro. Before a doctor arrived, a second negro waiter was unconscious, and the superintendent and several others were suffering such distress that they had been obliged to go to bed. The physician treated all of them for ptomaine poisoning and, after remaining for an hour or two, left, thinking that everything possible had been done.

While the superintendent and the others who had not lost consciousness improved, the two unconscious negroes rapidly became worse; and at one o'clock in the morning the physician was called again. Being unable to respond, he sent a second doctor, who found the first waiter dead, five other men unconscious and five more suffering seriously. This doctor, knowing the treatment that had been given by the other physician, called ambulances and taxicabs and sent the 10 men affected to the hospital. All of the men, except one of those unconscious, who died four days later, without coming to, improved on the trip to the hospital, and all of them were fully recovered within a few days. The hospital staff also attributed the illness to poisoned food. It is noteworthy also that the physician who sent these men to the hospital himself suffered from a severe headache and drowsiness on his return from the camp.

On Dec. 22 following, the superintendent and three other men returned to the camp, which had been deserted since the night of the eighteenth. All retired feeling well; but when the cook arose to get breakfast in the morning, he collapsed. The superintendent lost consciousness on the way to the telephone to call a physician; and before a doctor reached the scene, only one man of the four was able to move. All were sent to the hospital, where one died within three days of what appeared to be pneumonia, while the other three recovered. An examination of the bodies of the three men who died did not reveal any trace of their having eaten poison. It was then decided to conduct an examination to determine the poison that had caused the three deaths.

Camp Buildings in Good Condition

It was found that the camp buildings were in good condition and well kept, that the food on hand in the storeroom was of good quality and in good condition, and that, while the camp was equipped with stoves for heating, each had a pipe without a damper leading straight up through the roof. The inquiry indicated that the fires were not kept over night and that the windows in all the sleeping quarters had been kept open at night. The kitchen was equipped with a sink from which a waste pipe led through the floor, wastes being allowed to be absorbed by the earth. There was no gas in the camp, and no gas mains or pipes were situated near the camp. The old fill on which the camp was located consisted of dirt, slag, scrap, mill wastes, ashes and cinders and had been in place for five years for the most part. No material at all had been deposited there for six months. It covered an area of nearly two acres from 10 to 15 ft. deep.

About 10 days before the occurrence of the first illness an employee of the steel mill at which the camp was located noticed a little vapor coming from the dump about 50 ft. distant from the camp, and an attempt was made to dig a trench around the location of the fire thus indicated, in order to put it out. The dump was found to be frozen to a depth of 2 ft., but at a depth of 5 ft. red-hot cinders were encountered and a second trench was started 10 ft. back of the first. Hot cinders were found in this one also, and successive trenches were dug up to the site of the camp buildings, where hot cinders were found at a depth of about 5 ft. Six of the men engaged in digging these trenches became ill, and two had to be taken to the hospital of the rolling mill.

Trouble Laid to Carbon Monoxide

It was concluded from these conditions that the entire trouble was caused by a carbon monoxide poisoning, the gas being formed from the smoldering incomplete combustion of cinders and other material and being unable to escape owing to the frozen surface, except beneath the camp buildings where the ground had been thawed. The hot water from the kitchen sink probably established a flue for the escape of these gases from the fire beneath. The symptoms of the men affected correspond exactly with those of carbon monoxide poisoning, with no resemblance to ptomaine poisoning. The fact that the camp had been occupied for about three months without any serious consequences indicates that the gas had never previously found its way to the surface in quantities sufficient to produce poisoning.

Carbon monoxide is especially dangerous because it is odorless, colorless and tasteless, two or three parts per thousand in air being dangerous to life. The poison acts by combining with the hemoglobin, thus destroying the blood. Pneumonia is a frequent complication.

The camp in question was of course moved immediately to some distance from the dump, and canaries in cages were placed in all the sleeping quarters to guard against the chance of the wind carrying gas in dangerous quantities from the dump, which was torn up to extinguish the fire.

The investigation of these cases is described by Dr. Albaugh in the *Journal of American Health* for Apr. 7 last.

Dragline Eliminates Haulage Equipment on Railroad Work

By W. A. PILLANS

Assistant Engineer, Lorain, Ashland & Southern Railroad Company, Lorain, Ohio

ON THE Lorain, Ashland & Southern R.R. recently completed and now being operated by the Pennsylvania Lines, a dragline excavator was used in making heavy cuts and embankment with very satisfactory results. The conditions under which the machine worked and its performance will interest the contractor who has not considered the possibility of utilizing his dragline on this type of heavy grading.

The Essex Construction Co., of Buffalo, N. Y., with a Bucyrus machine, took a contract to grade the first four miles south of Wellington, Ohio. Nothing heavier than an 8-ft. cut was met on the first three miles, the machine borrowing for the fills and washing the cuts, swinging about 60 ft. of each end of each cut into the adjacent fill. On the fourth mile, however, a cut 3000 ft. long, 1100 ft. of which averaged 19 ft. in depth, threat-

DRAGLINE MAKES CUT WHICH NEEDS NO TRIMMING

ened to displace the dragline for a machine better suited for such heavy work.

Making a Cut by Dragline

The profile indicated a large amount of waste on the mile, and the fill at the south end of the cut could be practically made from the cut next south. The material from the big cut could not therefore be placed in embankment within the limits of such an overhaul distance as would not make the price paid for overhaul exceed the unit price paid for excavation. As on nearly all new lines, first cost was a necessary consideration, and it was decided to waste the cut with the exception of a small amount on the south end. The dragline in making the cut rode the center line, swinging the material into spoil banks on either side. But one move through the cut was required.

The dragline machine worked to a 0.57% grade and on a 40-ft. curve the entire distance and handled approximately 40,000 yd. of heavy, yellow clay and blue gumbo during the six weeks required to complete the work. The slopes were cut from a 20-ft. base one to one and required no hand dressing. Some sliding due to frost action has occurred, but the work compares favorably with similar work done by steam shovel.

Highway Made from Spoil

A feature favorable to the contractor was that a highway which crossed the cut at a very acute angle, thus making an overhead bridge on the original line impracticable, had to be reconstructed. The waste along one side of the cut came in handy for building a new road from one end to near the middle of the cut, where it crosses at right angles and swings again into the old highway. After completing the cut, the machine returned on the line of the new highway, riding the spoil bank and grading the new road.

The fact that practically all of so heavy a cut was wasted may lead to a criticism of the practice or even the location. The location was an imperative one chosen from several made under the direction of the late Joseph Ramsey, Jr., which fact would seem to preclude any criticism as to its correctness. The practice was governed by the necessity of taking first cost into consideration and actual waste on the mile. The additional right-of-way necessary for the spoil banks was purchased for $250, which does not offset to any appreciable extent the dragline's economy. The illustration shows plainly the results accomplished.

Embankment South of Wellington

Equally as profitable to the contractor and as good an example of dragline economy, although not so unusual a performance for this type of machine, is the work shown in one of the photographs, an embankment 11 miles south of Wellington, built by the same machine.

HEAVY FILL MADE WITH LITTLE REHANDLING AND WITHOUT ANY FORCE OR EQUIPMENT FOR TRANSPORTING MATERIAL

At this point, the line crosses the Baltimore & Ohio R.R. with an overhead crossing, the approaches to which are partly trestled and partly filled. The south approach is a fill 2300 ft. long, with a maximum height of 28 ft. built on a temporary grade of 0.7%. About 48,000 yd. of material was borrowed from pits on either side, having widths of from 30 to 80 ft. and a maximum depth of 14 ft. Two moves through each pit were made, except for a short distance at the small end of the fill. On the first move, near the outside of the pit, the machine took out the material and placed it about halfway to the center line. On the second move this material was recast into the fill and the remainder of the pit made. At the high end of the fill during the second trip the machine climbed the side of the fill in order to cast to the top.

From 10 to 20% was allowed for settlement, as a great part of the material handled was from low-lying ground saturated from spring rains. An early and thorough settlement of the fill occurred, and only ordinary maintenance attention has been required since. The land purchased for the borrow pits cost $250. The expense of temporary trestles was saved; and although some of the dirt was handled twice, the dragline did away with the usual transportation equipment and force.

EDITORIALS

Topographers Can Aid Airplane Program

IT TAKES a trained eye to "see ground," to visualize a map, in other words. To the layman and to many engineers, even, the topographic map is a record to be interpreted by tedious study; but to the expert topographer it is a living representation of the country it reproduces. To him, a glance serves to accent the relief and to bring out the nature of the country; in short, he sees the ground as though he were in an airplane, sailing slowly over it. The time has now come when this skill may be capitalized for the benefit of the country. The nation's program calls for a magnification of the war in the air, for the construction of 50,000 airplanes. This service will demand many types of men, but no one is more important than those who will make up the eyes of the air fleet; and, in the minds of the experts in Washington, no class of men is better suited for this service than the expert topographer fitted to convert the living map of the earth spread before him under an airplane into the miniature reproduction from which the artillery directs its fire and the infantry plans its raids.

The Centenary of the Erie Canal

ON JUNE 27, 1817, was signed the first contract for the construction of the Erie Canal across New York State, and pursuant to that contract on the following July 4 the work of building that famous waterway was begun by formal excavation just west of Rome. The present year, then, marks the centennial of the beginning of the most historically potent piece of engineering in the United States. Strangely enough, the year gives promise of a revival of the state canal as a factor in the life of the country. The hundred years since its start have seen marked changes in transportation. The Erie Canal served in its first few years to establish New York City as the premier American port so firmly that the railroads, when they developed a score of years later, were forced into New York City, although it was surpassed as a railroad terminal by several other of the Atlantic ports. Soon the growth of the railroad became so great as to make the value of the canal negligible. It had outlived its purpose long before the last part of the century in which it was built, though there were several heroic efforts to revive it. In fact, the latest revival, the $150,000,000 New York State Barge Canal, seemed to be a waste of public funds to many, until strangely enough, the war with its necessity for transport of goods to the coast at a time when railroads are congested beyond all hope of ready relief and when terminals are congested even more than the main lines of the railroads has brought to the front once more the possibility of water transport from the Lakes to the ocean piers at New York. It is too early yet to predict how much of this expected use of the New York State Barge Canal will materialize, but it can be said that in this year, 100 years after the first pick was driven into the soil to make the original canal, there is better prospect of its successor becoming a useful link in the nation's transportation system than at any time since it was initiated.

Strong Letters from Water-Works Men

THE twenty-odd strong letters from members of the American Water-Works Association printed in our last and present issues contain many constructive suggestions. They show faith in the future of the Association but belief in the need for new life and reform. They indorse the editorial position taken in our issue of May 17. The very few letters of protest received have been not against our criticisms but against our letter inviting the membership of the Association to voice their criticisms through our columns. Among the suggestions received are: Elimination of objectionable association politics; reforms in nomination methods; more democracy; less exploitation of the Association by self-seeking members; employment of a strong, full-time, well-paid executive officer; consolidation of American and New England Water-Works Associations. A belief that the Association is essentially technical but should make itself useful to superintendents and other water-works executives who have not had technical education and experience is shown. The letters are strong, representative, stimulating. They will help the American Water-Works Association find itself and fulfill its destiny of ever-increasing usefulness.

The Freight-Car Shortage Is Serious

ONE industry after another makes complaint relative to the freight-car shortage. It is asserted, for example, that roadbuilding in the Middle West has been brought almost to a standstill by the inability to get materials to the work. It is said, again, that cars are not to be had for the moving of Southern lumber, although Western lumber is moving with comparative freedom. There is no need to feign surprise at the situation, or to suppose that there is an absolute remedy whereby everybody can have an abundance of cars. During several years of depression the railroad managers, lacking the money to build cars, were predicting difficulty with the return of business. They did not foresee the unprecedented traffic brought on by the war, for which they would hardly have been fully prepared in any event. The immediate point is that the serious situation is here, and everybody must put his shoulder to the wheel. Partial relief can be obtained.

Better Loading and Faster Moving

FOUR LINES of improvement are open in the car situation—building more cars, distributing them better, loading them fuller, and moving them faster. The building of more cars is essential as a provision for the future, but it cannot bring immediate relief. Car distribution is in the hands of the special board of the

American Railway Association, and it can be assumed that the board is using its best efforts to put the cars where they are most needed. The public can help little here. The public's opportunity is in better loading and faster moving. Better loading is a matter of education, in which all shippers can take part. Nearly two months ago the special railway board pointed out that while the average capacity of all cars is 39.7 tons, the average load of revenue freight is only 15.5 tons, or considerably less than half the car capacity. Here is an easy way to increase the number of available cars, by making each car carry more nearly the load for which it was built. In the moving as well as in the loading of cars, the shipping public has ample opportunity to help matters. Consider the absurdly low average run of 25 miles per freight car per day. Increasing this mileage to 30 would add the capacity of 515,000 cars to the present supply. The railroads can and must use their best efforts to speed the cars up in transit and in the repair shops. But the public also has the cars in its hands a considerable part of the time, and it must load and unload them promptly. And it goes without saying that more should be done of what has already been started—the discontinuing of some passenger trains and the luxurious features of others—to the end that main tracks, yards, repair facilities and locomotives may be more fully released for the moving of freight cars and freight. The public should not oppose these reductions in nonessential passenger service.

Price-Fixing Must Meet Two Basic Demands

THE matter of the arbitrary fixing of prices for materials bought by the Federal Government has reached the point where it demands the earnest attention of economists and of able persons more familiar with industry, and especially with the steel industry, than any of the officials who have so far engaged in combating excessive profits. In view of some unscientific and dangerous attempts at price regulation that have been made of late, it is gratifying to note that a movement is under way to regulate prices not only of finished products bought by the government, but of all materials entering into those products, and, more important yet, of the price at which the same materials are to be sold to the general consumer.

The two basic requirements of the present situation are expressed in this movement. Prices must be fixed wisely, on the basis of expert study; and they must be fixed for the private consumer as well as for the government.

The seriousness of the situation is emphasized by facts with which everyone who reads the newspapers is familiar. In the face of a report by the American Iron and Steel Institute that steel products for ship construction cannot now be sold for less than $95 a ton at any profit to the producer; in the face of the fact that pig iron is selling at and above $50 per ton, and that enough coke to make a ton of pig iron now costs more than $20, more than the market price of pig iron a year ago, the Secretary of the Navy maintains that ship steel is worth only $65 a ton. This opinion, given after an investigation, the methods of which are not known, by a man who prior to taking office had no connection with or knowledge of the steel industry, is about to be imposed upon the steel industry by means which are not advertised, and in a manner bordering on the confiscatory. Not only a former newspaper publisher, but also a man whose experience has been confined to the lumber business has taken a hand in this sort of price fixing; the chairman of our shipping board has declared, after an even more cursory and private investigation, that ship steel sold at $56 a ton will yield a handsome profit to the makers.

The tendency thus evidenced to disregard the knowledge of men connected with the industry and the findings with regard to fair prices of bodies in a position to know whereof they speak is dangerous. It is to be hoped that, should the Federal Trade Commission or the Council of National Defense be intrusted with this work, the findings of such a body with reference to maximum prices will be made binding on the executive officers of the government. Should any agencies bring about the fixing of a price to the government on steel products below production costs plus a fair operating profit, the private consumer obviously could not be allowed to enjoy the same price. On the contrary he would have to pay a greatly increased price; the country in general and construction work in particular would suffer from it in a serious and needless manner.

The first result, should the government insist on being furnished at too low a price with, say, 10% of the country's steel output, reducing by that amount the supply for all other purposes, would be to increase the price of steel to all other consumers up to and probably beyond the point at which the steel companies would recoup the loss on all material furnished the government. The heavy current demand, which has already responded without a waver to the most astounding advances, puts this matter beyond dispute. Thus, while well-meaning officers were saving a direct taxation burden to the country in securing a slightly lower price on direct government purchases, they would be levying an indirect, special, unbalanced tax on all users of steel products, probably in excess of the direct taxation which they might save. As the government came to take more and more of the steel output, the effect would become increasingly serious. The power of taxation, it must be remembered, is conferred on the legislative branch of the government, and cannot be assumed by an executive officer without something akin to usurpation of authority.

In addition to the illegal taxation that would thus be imposed, however, there lies in unwise price-fixing a grave threat of derangement to the many and exceedingly important steel-consuming industries of the country. This threat is especially serious to all construction work into which steel enters. There are no definite figures kept, but it is safe to say that high prices have already cut the annual use of steel in new construction of all sorts to less than 5% of the total output. The inevitable result of unscientific price-fixing—such for example as advocated by the heads of the navy and the shipping board—would be to cut it still further, to reduce the volume of work and to postpone much work that is needed, war or no war. Such action would put a harmful curb on all steel construction that should and might be carried on in spite of high prices.

The country can afford to take no chances with the fixing of maximum prices by persons unfamiliar with the industry concerned. This is no time to take account of personal prejudices or preconceived notions as to how much it ought to cost to make something. Therefore it is encouraging to note that the present proposals contemplate getting at the root of the matter by a real investigation, fixing all the prices involved in the production of steel clear back to raw materials and the cost of food and clothes for the labor engaged in the industry.

From all consideration on the subject it will be clear that the price fixed for government purchases must be a *fair* price. Anything else will result in serious injury to the country. It is equally clear that, once a fair price is fixed, it must be the same to government and to private consumer. Finally, price fixing can not deal with finished material alone, but must extend down to the ultimate sources, the raw materials.

Even this, though done in the wisest and most far-sighted manner, may not succeed unless the price-fixers take into account the fact that some plants and some sections can always produce for less cost than others, and the fact that large stocks of various materials of manufacture, bought at high prices, are already on hand at many plants, and must be worked off gradually. No amount of price fixing can take the money paid for these materials out of the pockets of those who sold them and return it to the manufacturers.

In view of the serious consequences which mishandling of this matter would have for construction work and for the general public, and in view of an evident tendency on the part of some to mishandle it if given too free rein, the readers of *Engineering News-Record* should keep a close watch on the doings of whatever body is selected to look into the matter, and should unite in helping it to get at the truth and avoid fatal blunders.

Knowledge of Column Strength

A TESTING campaign planned on a large scale and carried out with brilliant precision has been completed by the United States Bureau of Standards, to the great benefit of the engineering profession and those who use the engineer's services. Its outcome is to provide definite and new information on the strength of steel columns. Results were obtained that form the basis for far-reaching conclusions.

Strange as it may seem, we have had hitherto no really comprehensive test knowledge concerning the strength of steel columns. In the quarter-century since steel came into use, only a few small, scattering sets of column tests have been made, and even these more often gave negative results than positive. This is not the place for a review of prior tests, but the plain fact may be stated that the two hundred or so tests of large-size columns in the present series provide the first satisfactory steel-column data that we possess.

Among the big results of the series are these: Solid-section columns and well-built columns of open section are not subject to local failure, but remain in service undamaged up to the point where bodily bending or buckling of the column occurs; this buckling action utilizes the full compressive strength of the metal, the quantity known ordinarily as the compressive yield-point. The shape of column cross-section is immaterial. The effect of column length justifies the accepted column formulas, with a strength-reduction of about 25% between slenderness-ratios 25 and 75. For ratios below 25, no increased strength can be counted on, which again corroborates prior beliefs.

All appearances are that the bending stress arising from small initial eccentricity of load, of metal or of resistance, increased by that due to the resultant buckling, adds to the direct compression until the metal on the concave side of the column reaches its compressive yield-point. In all (or nearly all) cases the failure is quick after the yield-point is passed: Elastic failure of the metal spells structural failure for the column. But in the very short columns, of length-ratio about 10, buckling is so minor a factor that direct axial squeezing remains dominant even after elastic failure, and a largely increased load can be carried beyond this point, the column slowly crushing down. An exception to most of the above statements is found in the case of tie-plated columns, whose strength is low; this fact has been accepted by many engineers in the past, on theoretical grounds, but there was no proof by test to refute the favorable opinion which some other engineers held of this type of column.

But the biggest fact of the whole investigation is that some lots of steel (we speak now only of standard commercial bridge steel) make much poorer columns—that is, weaker columns—than other lots of steel—and that *we do not know how to recognize the weak steel.* In other words, the standard tension test, which is the only criterion by which steel is bought and graded, fails to distinguish between good and bad column steel. Most of our bridge steel produces columns having a strength of 34,000 to 37,000 lb. per sq.in. (at length-ratio 25), but other columns are weaker by one-sixth to one-third.

So long as the weak columns are not sorted out from the strong columns, we must, for safety, assume that all columns are weak. We must proportion all columns as though their ultimate basal strength were only 27,000 lb. per sq.in., instead of 35,000. This represents 30% increase section of metal.

The view may be taken that this is satisfactory. At least one engineer closely concerned with the column question has stated to *Engineering News-Record* that 27,000 lb. is strong enough for a column, that it gives a sufficient safety margin over customary working stresses. This is true and good, so far as it speaks for the safety of existing structures; but it has no meaning for future design. If proper means of selection should make it possible to get columns possessing 25% greater strength—in other words if all columns could be as good as our best columns, by eliminating those made of weak steel, there would be corresponding economy to be obtained in all future construction.

So far as the present test facts indicate, nothing stands in the way of getting this increased column strength except a reluctance to devise and apply methods of test by which the higher-strength column steel can be selected. Under the present year's urgent need for economy, with steel commanding tremendous prices and a real shortage of structural steel already existing, mere inertia of custom must not stand in the way of an obvious step toward saving steel.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors will be Welcomed

Heap Test Only One Indication of Excellence of Concrete

Sir—I have read with interest Mr. Harrison's letter in *Engineering News-Record* of June 7, commenting on my recent article in this paper entitled "Concrete Consistency Measured by a Simple Field Test." In defense of this test, I should like to note that Mr. Harrison's very convincing criticism is directed not against the test itself, but against a peculiar misinterpretation of its scope and purpose very different from anything I stated or intended to imply in its description.

One cannot deny Mr. Harrison's point, "The simple truth is that any good foreman could meet the proposed specification with undermixed and overwatered concrete." It is plain that the specification could be readily met by concrete abused in this or many other ways—for example, with all the cement left out. The heap test certainly cannot be expected to dispense in any way with the necessity for complete control over the ingredients of concrete and the time and manner of mixing. It is not intended to furnish a general guarantee of excellence, but is simply a field test for consistency and implies nothing as to the quality of the concrete on which it is used, except that in one more of the many operations in its manufacture systematic control has replaced guesswork.

HAROLD A. THOMAS,
Associate Professor of Civil Engineering,
Rose Polytechnic Institute.

Terre Haute, Ind.

Design of Imhoff Tank at Fort Benjamin Harrison

Sir—In the June 7 issue of *Engineering News-Record*, a brief description, with illustrations, is given of the sewage-disposal plant now under construction at the officers' training camp at Fort Benjamin Harrison, Ind. Included in the disposal plant is an Imhoff tank, and in the description of the plant the statement is made: "The plans for the tank are reproduced here in somewhat more detail than ordinarily the simplicity of the plant would warrant, as other camps may be confronted with a similar problem."

The statement seems to imply that this tank might perhaps serve as a model on which to base the design of Imhoff tanks at other training camps, should tanks there be needed. It is for fear that this is just what may happen that the writer feels called on to point out that some features of the design are not in accord with good practice. It is appreciated that but little time was available for working up the design and that the two features which the writer will call attention to may therefore have slipped through without sufficient consideration. The writer refers (1) to the arrangement for admitting the solids from the settling chamber to the sludge chamber, and (2) to the possibility of having a current of raw sewage flow through the sludge chamber. Reference should be made to the diagrams on page 507.

In designing the slot between the settling chamber and the sludge chamber it is better to so arrange the construction that the sliding through of the solids into the sludge chamber will be facilitated rather than retarded. If the design will be examined, it will be seen that the solids sliding down the sloping bottom of the settling chamber tend to bring up against the shoulder provided to prevent the escape of gases up through the slot into the settling chamber. Similar constructions elsewhere have given trouble, clogging up the slot, due to the accumulation of solids on the shoulder. Again, it will be seen that the cleaning of the slots will be more difficult than with other arrangements that readily suggest themselves.

With reference to the second feature, the possibility of having a current of raw sewage flow through the sludge chamber, it will be seen that two settling chambers are provided and that they are connected, one with the other, by means of the sludge chamber. If, in operation, the hydraulics are such that the same volume of raw sewage that is admitted at the inlet end of each settling chamber passes out at the outlet end of the chamber, then no flow of raw sewage should occur through the sludge chamber from one settling chamber to the other. But with the design shown, only a glance is needed to see that it may be found extremely difficult to secure this result, due to irregularities in construction and differences in head on the inlet and outlet gates. Not only is it possible, but extremely probable, that even with all eight inlet and outlet gates wide open a current of raw sewage will flow through the sludge chamber; and if some of the inlet or outlet gates, or both, are left closed or partly closed, a current of raw sewage is almost sure to flow through the sludge chamber. Such possible conditions should be avoided, and with a different design they can be avoided.

The writer does not mean to go as far as to say that the tank in question may not be made to operate satisfactorily, but he has seen similar conditions elsewhere where tanks having similar features of design did not operate satisfactorily. And it is to sound a word of warning to him who, through lack of experience, with the best of intentions, copies or follows closely the design shown, that the above has been written. OPERATOR.

When Ship Freight by Motor Truck and When by Rail?

Sir—The writer has read with great interest the article under the above title by Prof. C. C. Williams in *Engineering News-Record* of May 10, p. 315.

Professor Williams complains, "Competition of motor-truck haulage is becoming more and more a matter of serious concern on the part of the railways. Just as they have had to accept the competition of electric interurban railways for certain classes of traffic, they are now facing a similar competition from motor trucks on improved highways." Later he says, "From the foregoing analysis, the desirability of reducing terminal costs becomes manifest, if the railroads are to hold the com-

petition from motor trucks to a minimum"; and again, "The case is a repetition of the struggle between the inland waterways of an early day and the railroads."

The writer cannot but feel that the exigencies of the present transportation situation are lost to Professor Williams and that his fears for the well-being of the railroads are premature. It is needless to enter an extended discussion of what has been conclusively demonstrated during the past year—namely, that the railroads are incapable of transporting the greatly augmented tonnage of commodities which has been presented for shipment. They have not been able to supply cars or motive power for this purpose.

On already deficient railroad service are now placed the further demands created by our entrance into the war. The entire situation is not one in which the railroads need protection from competing means of transportation. Rather, the case is stated by saying that the country urgently requires every supplemental means of transportation which can be made of service, if industries are not to be further sapped of their vitality. Without the relief motor trucks can supply, shipping conditions are going to become worse rather than better.

The Cleveland-Akron Highway in Ohio affords a striking illustration of the point in question. This road is improved for a distance of 40 miles to Cleveland, so as to make feasible the relief sought; and it is still to be noted that Akron railroads are taxed beyond the limit of their capacity. The statement was recently made that, if this road were to be shut off to motor-truck transportation, 20,000 men would be thrown out of work in the City of Akron. A recent traffic count over this highway showed a total tonnage of 890 in 72 hours, composed of all varieties of commodities. Were our public highways all developed to the extent to which this highway has been developed, the transportation problem that exists today could not have arisen.

Any theory which holds that the railroads are going to suffer from motor-truck competition fails to take into account two well-demonstrated facts—first, that the railroads make but an indifferent profit from short-haul less-than-carload-lot freight shipments; and second, that they are unable to care for the freight presented to them for long-haul carload shipments.

Professor Williams's concluding statement, "There is ample room for both the railway and the motor truck, and it is hardly necessary that either enroach on the field of the other," well expresses the present situation; but Professor Williams has arrived at this conclusion from an entirely different line of reasoning than present circumstances make tenable.

Instead of decrying and seeking ways to limit motor-truck transportation, every means should be extended to bring our trunk highways to a condition that will permit motor trucking with certainty and dispatch. It is urgently needed now; it will be more urgently needed later, particularly when we know of manufacturers who are forced to ship such commodities as copper, aluminum and farm machinery in carload lots by express, instead of by freight.

MAURICE B. GREENOUGH,
Chief Engineer,
National Paving Brick Manufacturers Association.
Cleveland.

American Water-Works Association —As Its Members See It

"Radical Reform Needed"—Horton

Sir—It has seemed to me for some time that radical reform was needed in the organization of the American Water-Works Association. I believe there are several men who have been working strenuously and conscientiously to bring about this reform. I think, however, there has been a certain element in the association which was greatly misguided as to the functions of such an organization. I believe that an organization of this kind should live up to its agreements in a businesslike way with outsiders, and it should live up to its agreements with its own membership in matters of publication of papers, etc.

It has seemed to me that there was a certain clique in the society which for some reason or other furnished numerous papers which were published in the "Proceedings"; and if there were expensive reprints to be made, apparently they got these reprints where others, as I know personally, have been unable to get reprints even when they offered to pay for them themselves. I know of men who have been members of the society for many years, who have never been asked to present a paper or give experience. I think that the society should at least be representative of its own membership, and I do not think it has been representative of its own membership in the past. The organization should be conducted on the square, without favoritism, without efforts to secure undue advertising for particular persons.

ROBERT E. HORTON,
Consulting Engineer.

"A National Technical Society"—Hopkins

Sir—Referring to your editorial in *Engineering News-Record* of May 17, on "Revolution or Reform in American Water-Works Association?" the writer indorses your statement that the association is a national technical society with a real reason for existence, rather than a united brotherhood of water-works superintendents. Although the early constitution of the association plainly had for its prime object fraternal intercourse between those engaged in water-works management, the admission to membership at that time of those engaged in the design and construction of water-works made it inevitable that the association would more and more take on the character of a technical society, without which it is questionable if it could have survived. The object of the association, as stated in Article II of the constitution, is at the present time far more broad than it was 30 years ago when the nontechnical idea was apparent, when there was about 30% of the active membership professional engineers as against about 42% at the present time, including chemists and bacteriologists.

The last active-membership list of the association shows that about 32% are superintendents and managers of water-works and about 26% unclassified or in miscellaneous occupations. Of the superintendents and managers, many are educated and highly trained men, and as to technical ability rank with the professional engineers. This is also true of many of those classed among the 25% of miscellaneous. It, therefore, seems clear that there are now probably few members who do not appreci-

ate and desire technical papers. However, technical papers should continue to be written, as they have been up to the present time, as free as possible from matter unintelligible to the average of water-works superintendents and managers, or we may expect them, in these days of many societies, to swarm the hive which they have considered theirs. Papers of a highly technical character might be presented more properly to some other technical society.

The constitution, as it now stands, appears to me to be comprehensive, excellent and to meet quite well the requirements of the association. Frequent and unimportant amendments to it are to be deprecated. To prevent a recurrence of the unfortunate result of the recent balloting for officers, the constitution might properly provide for the written consent of a member before he be placed in nomination for any office.

The constitution should also provide for the notification to the members of any proposed amendment. a fixed time in advance of the meeting at which voting on such amendment is to take place.

Although papers presented at the meetings of the local sections have been edited and printed in the "Journal," there appears no section of the constitution specifically authorizing it.

CHARLES C. HOPKINS,
Rochester, N. Y. Consulting Engineer.

"This Is the Time for Active Coöperation"—Conard

Sir—It seems to me there is room for all of us in the American Water-Works Association, and even more than the present number, both of the so-called technical men, the practical men, and those who produce the commodities that are used by the two classes mentioned. I also think that this is the time for active coöperation and team work on the part of everybody. If in the judgment of those who by a majority vote have been placed in charge of the affairs of the association there is certain work to be done, let us any and all stand ready to cast aside personal feelings of whatever nature, and make common cause to place the American Water-Works Association where it ought to be in the field of the great national associations of the American Continent—in the front ranks.

W. R. CONARD,
Burlington, N. J. Inspecting Engineer.

Fall Conventions and Single Association

Sir—My first suggestion relates to the time of holding our conventions. Each superintendent has his hands full at the convention time. A week's vacation by the merchant at Christmas would be suicide or else show that the merchant should get into some other business, as his own would run without him. A second advantage in the fall would be to get the full benefit of the manufacturers' exhibit. This is often of more importance than the papers, as the best engineers are spending all their time to solve our problems. In the fall we would have the chance to order for the spring rush.

I believe in one association divided into sections. I know the New England Association has better ideals and closer association of its members, but does it not tend to take away from our main association? Would not all be better off if it were merely a section?

SUPERINTENDENT.

Society Service

A Section Dealing with the Results of Teamwork by Technical Men

RESULTS have been secured in Rhode Island, where practically all the resident members of the national engineering societies, together with twice as many more not so affiliated, are associated in the Providence Engineering Society, a membership of over 500. The general meetings of the past year have had an average attendance of 275 and the section meetings, of which there were 37, an attendance of 45. Local topics discussed at these meetings have aroused a great deal of public interest.

The society has been instrumental in securing important state legislation, has taken an active part in public safety work, has made an engineering census of Rhode Island, and is helping the advancement of technical education in the public schools. This means that the engineers of Rhode Island are getting acquainted with each other and have the inspiration of working in a common cause. It means that they have an opportunity for original work of a public nature and the development of personal initiative. It means that the society has at its disposal facilities for obtaining the opinion of every engineer in the state upon any matter of public interest. In other words, the society is thoroughly representative of this state as a unit of the nation.

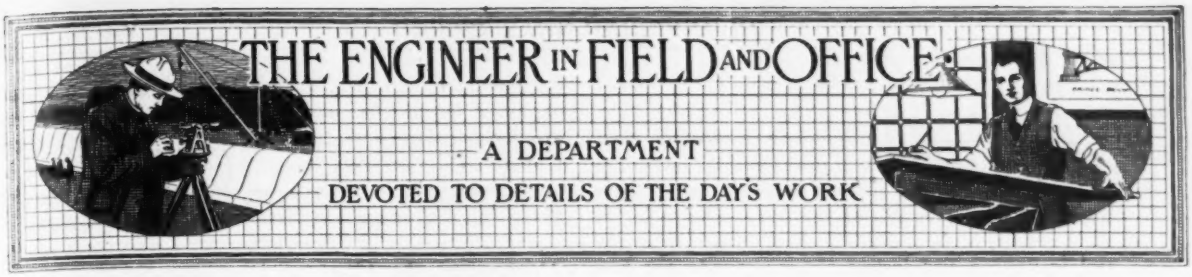
ENGINEERING ASSOCIATION OF NASHVILLE

One of the first things this organization did of a civic nature after it ceased to be a chapter of the defunct Engineering Association of the South was to kill a $2,000,000 bond issue hungry politicians decided to load onto the city for additional water-works and a light plant. The task of presenting to the Government the case of the proposed Mussel Shoals hydro-electric plant for the manufacture of nitrate was turned over to the society. A bankrupt railroad runs out of Nashville. A recent agitation for the bankrupt city to buy the bankrupt road has resulted in the society's taking up this $4,000,000 problem and presenting it before the public in the proper light.

CLEVELAND MATTERS

The parent society has turned over to the Cleveland Association of members of the American Society of Civil Engineers, 22,000 books, duplicated by the library of the Engineering Societies Building, for deposit in the library of the Cleveland Engineering Society. A plan is under way to have the society library made a branch of the Public Library, probably retaining the present librarian, G. H. Tinker, who was chiefly responsible for obtaining the gift.

Each delegate to the last Conference on Coöperation has been furnished with a mimeograph copy of the stenographer's report by C. H. Crawford, assistant engineer, Nashville, Chattanooga & St. Louis R.R., and representation of the Engineering Association of Nashville. A few copies are available for general distribution upon application to Mr. Crawford or to C. E. Drayer, secretary, Cleveland Engineering Society.



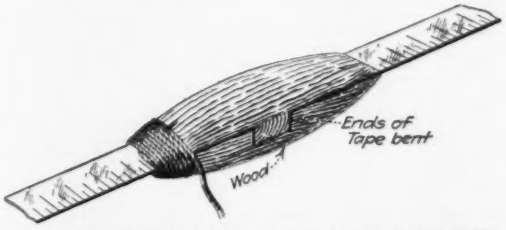
Simple and Certain Field Repair for Broken Steel Tape

By SAMUEL WARREN

New York City

FROM time to time there appear in the engineering magazines, methods of repairing a steel tape in the field. Most of them will slip without entirely pulling apart and are a constant source of worry. The method outlined below is guaranteed not to slip.

Heat each of the broken ends with a match, drawing the temper for about a quarter of an inch, so that it will bend without breaking. Slip the end between the



THIS REPAIR MAKES SLIPPING IMPOSSIBLE

blades of your knife and bend to a right angle. Then proceed to mend it by splitting a small stick and making notches in one half to take the bent ends. Wrap with a piece of twine after tapering the ends of the stick so that it will not catch in the brush. Then proceed to chain—and don't worry as to whether your tape has stretched half an inch at the splice.

Piles Are Driven by Four-Foot Drop

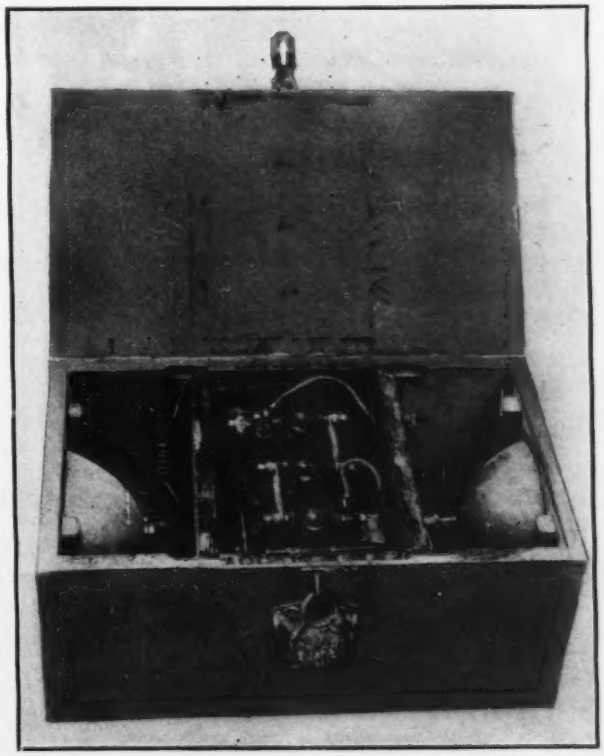
LIGHT blows with a drop-hammer piledriver were required in driving piles for the fenders of a new ferry transfer slip for the Baltimore & Ohio R.R. at Baltimore, Md. The piles are of oak, about 50 ft. long, specified to be 8 in. in diameter at the small end and at least 12 in. at 4 ft. from the butt. The water is about 19 ft. deep, with 3 ft. of soft-mud bottom and then material hard enough to require the use of rings on the pile heads and light blows from the 2250-lb. piledriver hammer. The average drop is only 4 ft. The drop hammer was used because it was a part of the contractor's equipment, but owing to the hard bottom it became necessary to coax the piles down rather than to drive them with heavy blows.

The specifications required that for the last 10 blows the drop should be 20 ft. and the penetration not over 5 in. It was found that such a drop in combination with the hard bottom caused breakage of the piles. The last blows, therefore, were made with a 10-ft. drop, which gave an average penetration of about 1 in. per blow. The railway company's engineer keeps a record of each pile, showing at first the number of blows for each 12 in. of penetration and later the number for each 6 in. For the last blows the penetration per blow is noted.

The piles are driven 9 to 10 ft. into the hard material, some requiring 147 to 153 blows. From 20 to 24 piles per day are driven, more time being consumed in moving the piledriver, selecting the pile and getting it into the leads than in driving it into the ground. The work is being done by the Phœnix Construction Co., of New York. It is under the direction of W. S. Bouton, bridge engineer, Baltimore & Ohio R.R., and G. E. Schaeffer is inspecting engineer in charge for the railway company.

Electric Tunnel Lights in Closed Box for Safety

IN THE construction of the recently completed Cleveland west-side water-works tunnel, W. J. German, engineer, Federal Bureau of Mines, ordered that all lights should be of such a character that they could not ignite the explosive mixture of gas found in the tunnel. The



AUTOMOBILE BULLET LIGHT, SET IN THE END OF A BOX AND DRAWING CURRENT FROM A STORAGE BATTERY, MAKES SAFE TUNNEL ILLUMINATION

cap lamps worn by the men are of the Edison storage-battery type, locked and unlocked above ground, but the lights used in construction work itself, which are nec-

essarily larger, are built into a very carefully constructed box.

The reflectors are "bullet" automobile headlights, each containing a 24-watt lamp that is protected by wire-glass and connected to a 90 ampere-hour Willard storage battery set midway of the length of the box. The latter is 13 in. wide, 10 in. high and 23 in. long, outside dimensions, and is lighted and locked above ground—the key being kept there. The carpentry work on the boxes is of a very high grade, all joints being tight, serving to keep the explosive gas out of the box as much as possible, in the event of a spark being caused by a loose connection at the battery.

This arrangement of tunnel lights was developed in the Cleveland Water Department, though its prototype was probably that of John W. Dolman.

Save Trouble by Using Well-Built Forms

AS THE engineer watches the ordinary contractor set his side forms for concrete roadwork, he easily realizes that not enough consideration is given to their construction and grade layout—facts which later on are sure to cause much extra trouble and loss of time. The forms should not of course be built to a degree of over-nicety, but should be so constructed as to prevent their becoming easily bent, warped or worn out of shape. Another feature oftentimes overlooked is the desirability of staggering the joints, thus preventing an undulation forming across the road in case the joints are out of grade. To

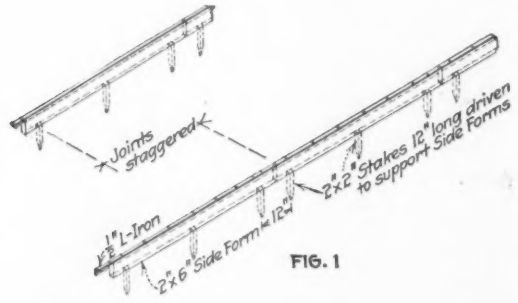


FIG. 1

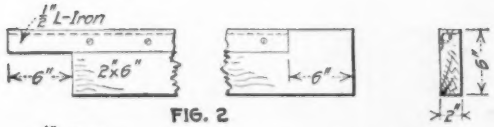


FIG. 2

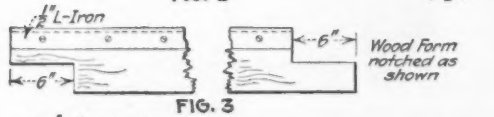


FIG. 3

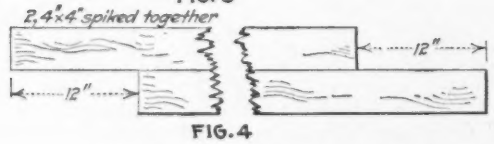


FIG. 4

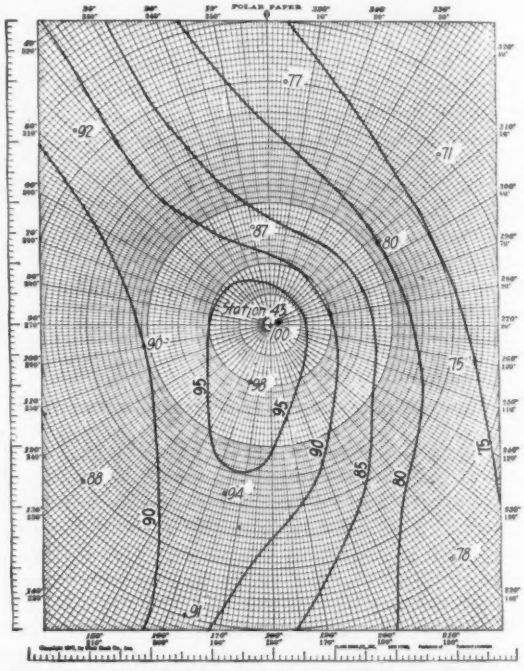
STANDS MUCH ROUGH HANDLING

obtain a method of easily supporting side forms for grade, 2 x 2-in. wooden stakes are driven to the proper elevation of the bottom of the form; and they, in conjunction with alignment stakes which are not shown, and together with the method of staggering the joints, make a satisfactory arrangement. Figs. 2 and 3 show details of wooden side-form construction, Fig. 2 showing the angle iron extending 6 in. beyond the end to insure that adjacent forms will be maintained at the same elevation. Fig. 3 shows a modified design that prevents the angle iron from becoming easily bent when the forms are roughly handled, while Fig. 4 shows a side form made entirely of wood.

Reducing the Cost of Plotting Stadia Notes

By CHARLES R. THOMAS
Assistant Engineer, Construction Service Co., 15 William St., New York

BY PLOTTING stadia notes on separate sheets such as are shown in the accompanying sketch and tracing the finished map from these sheets, the cost of plotting stadia notes has been materially reduced and the speed al-



SPEEDS UP INTERPOLATION—INCREASES ACCURACY

most doubled. Plotting topography by this method becomes independent of drafting-room equipments, a lead pencil being the only tool required.

The ordinary method of procedure is to sketch the topography in heavy pencil lines and either paste the sheets together for the draftsman or send them to him separately. The sheets are placed under the tracing cloth, and the finished tracing is made directly from them. The paper used for ordinary work is 8½ x 11 in. in size. Using a scale of 100 ft. to the inch, a length of 1000 ft. and a width of 600 ft. of topography may be plotted on each sheet. Topography may be plotted by surveyors on rainy days, either in the field or in the office, several men working independently on separate parts of the notes. It is remarkable how much the use of a graduated paper speeds up the interpolation of contours and increases the accuracy of scaling.

This method of plotting topography was developed during the past year by R. T. Dana, chief engineer of the Construction Service Co., using polar coördinate paper secured from the Clark Book Co., New York.

Tinned Copper Is No Better Than Tin Plate as a Roofing Material

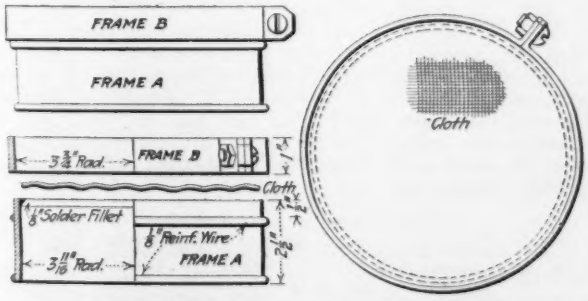
THE Bureau of Standards has recently investigated the unusual and interesting corrosion of the roofing material of the Library of Congress. This building has been covered since about 1893 by tinned sheet copper that has become covered within the last 10 or 15 years with small pits; in many cases these pits have extended completely through the sheet. Such a condition is interesting, particularly in view of the fact that Washington is uncommonly free from smoke, which is ordinarily understood to be a strong accelerating factor in corrosion. The investigation has shown that the corrosion was due to no accidental inferiority of the material, but that it is to be considered as characteristic of all material of this type. It appears, therefore, that tinned copper is not superior in any way to tin plate for roofing material and that in view of its greater cost can no longer compete with it.

Tinned sheet copper is used also for containing vessels such as milk cans and for fittings such as troughs, etc., for soda fountains and breweries. It is probable that such articles would also be subject to pitting corrosion of the same type if they were not worn out by actual abrasion before the corrosion had proceeded far, according to Technologic Paper No. 90.

Cost of Sieves for Testing Laboratories Reduced

SINCE in the routine testing of portland cement it is necessary to determine the fineness of samples at frequent intervals, a number of sieves must be used continuously. Where several hundred tests are made daily, many sieves of the same mesh must be available at all times. Figuring the wear and tear to which these sieves are subjected, even with the most experienced and careful operator, the replacements result in the cost of the fineness test becoming an appreciable item of expense.

The high grade of 100-mesh and 200-mesh sieve cloth may be obtained commercially. Many laboratories use this cloth with frames somewhat similar in construction

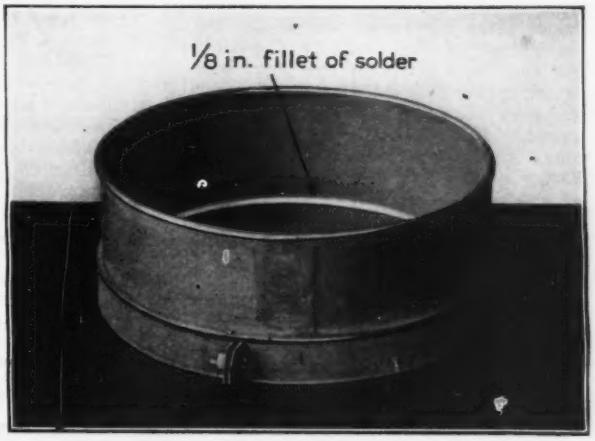


ADJUSTABLE RING MAKES TIGHT JOINT

to the ones illustrated, which are in service in the laboratory of the Universal Portland Cement Co. About 7½ in. in diameter, the frames are made of $\frac{1}{32}$-in. sheet brass and reinforced with ⅛-in. diameter wire. Sieve cloth is received in 36-in. squares and cut into 9-in. squares, which is the proper size for a 7½-in. frame. The cloth is then placed over the main frame *A*, after which the frame *B* is forced on, holding the cloth rigid and in place. If the frames are fitted properly, there is no tendency for them to separate while the sieve is in use; but if they should become loose, this difficulty may be overcome by several wrappings of adhesive tape around the sieve or by a rim provided with wings and a bolt, as shown in the illustration.

Objection to these frames is that in forcing the retaining ring over the main frame a strain, which results in eventual failure of the sieve cloth near the frame, is brought to bear. In order to permit the further use of the cloth discarded from the 7½-in. frame, several sets of frames 6½ in. in diameter are provided.

The life of a 200-mesh cloth subjected to average usage in the Universal Portland Cement Co.'s laboratory varied from one day to twenty days until some time ago, when



FILLET OF SOLDER EXTENDS LIFE OF SIEVE CLOTH THREE TIMES

the suggestion was made that a ⅛-in. fillet of solder be placed around the sieve at the inside juncture of the frame and the cloth. The results obtained are remarkably gratifying—one 200-mesh sieve that has been in service continuously for 90 days is still in excellent condition and will undoubtedly continue satisfactory for some time to come. Two other 200-mesh sieves with cloth soldered in have been in use 55 days and 63 days respectively and are still serviceable.

The results obtained by soldering 100-mesh cloths in the frames are proportionately good; 100-mesh sieves are subjected to much more severe usage than are the 200-mesh sieves, the average life of a new 100-mesh cloth having been from 7 to 10 days previous to the introduction of the fillet of solder. Several 100-mesh sieves, with the cloth soldered in, have been in continuous use for 19 days and are still satisfactory, while two others gave 37 days' service each with slight repair. From this experience, the soldered fillet seems to increase the average life of the cloth at least threefold.

The cost of soldering is negligible. When a cloth can no longer be used in a 7½-in. frame, it can be cut out and soldered into the 6½-in. frame. In addition to the great saving in sieve cloth, experience indicates that it takes less time to determine the fineness of a sample, as there is no opportunity for the residue to be retained between the cloth and the frame, as was sometimes the case with the previous design. For the same reason, the fineness results obtained by different operators on the same sample will check more closely.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

Los Angeles Becomes Shipbuilding Center

New Company Incorporated for $1,500,000 Is Constructing Steel Food Ships

A new shipbuilding company was recently incorporated in Los Angeles as the Los Angeles Shipbuilding & Drydock Company, having a capital of $1,500,000, all subscribed. Within a few hours after the completion of the organization of the company a permit for the construction of the plant was issued by the City Building Department and excavations were under way. The grounds for the plant consist of 70 acres in the west basin of the inner harbor of Los Angeles, about 30 acres of which will be used at this time. The plans for the first unit provide for a dozen buildings, large yards, and four building ways.

Within a short time three dredgers will be working night and day filling in portions of the site. Each of the four shipways to be laid out at this time will be 500 feet long by 60 feet wide. Three more ways will be built when the second unit of the plant is added. Among the large structures to be built this summer will be the laying out buildings, the main machine shops, foundry and carpenter shops, general warehouse and buildings for auxiliary construction, together with main office buildings. There will also be a wharf 500 feet long by 60 feet wide equipped with "sheer long" and other lifting machinery. One of the modern features of the works will be a complete aërial tramway system. The next step in the construction will be the building of a 50,000 ton drydock 750 feet long by 90 feet wide.

Has Contract for 8 Ships

The company has contracts from the United States Shipping Board Emergency Fleet Corporation for the construction of eight steel vessels. It is expected to have the keels of four of them laid by July or August. Each of the eight ships contracted for will have a dead weight of 8800 tons and will be 420 feet in length with a 56 foot beam, and will cost in excess of $1,500,000. By the terms of the company's agreement with the Board the first and second ships are to be delivered in April of next year, the third and fourth ships in May, the fifth and sixth in September and seventh and eighth in October. It is expected that the company will have 1000 men in its employ by July and at least 3000 when construction is well under way. Mr. Fred. L. Baker, head of the Baker Iron Works, is the President and Treasurer of the company. Mr. Fred. A. Gardner will be the Superintendent and Chief Engineer.

Asks for $1,000,000 for Submarine Base at Panama

Secretary Baker has sent a communication to the House, asking for an extra appropriation of $902,625 for the new submarine base at Coco Solo Point, Panama, Canal Zone. The original appropriation carried in this year's sundry civil bill was $750,000.

Portland To Build More Docks

On June 4 Portland, Ore., voted to issue $3,000,000 in bonds for the purpose of improving the port. The Dock Commission's plan is to construct a first unit bulk elevator of a capacity of 1,000,000 bushels and in connection with the handling of grain, a dock or warehouse approximately 1000 feet long and about 175 feet wide. The proposed layout provides for pier and slip construction and this will include the facilities mentioned above and also a large open dock area to be used for handling bulk material such as lumber, rails, structural steel and other commodities which do not, as a rule, require shedded space.

It is expected that the immediate construction, including the cost of the site will be in the neighborhood of $2,000,000—the remaining $1,000,000 of the bond issue to be held in reserve for such future requirements as may be demanded by shipping.

Engineers Organize in Baltimore To Develop Palestine

A number of civil, mechanical and electrical engineers who are delegates to the convention of the Federation of American Zionists which is meeting in Baltimore this week organized the Zionist Society of Engineers for the purpose of lending their technical ability to the work of developing Palestine along national lines. They chose Max A. Greenberg, mechanical engineer, Chairman, and Perez W. Etkes, civil engineer of the Public Service Commission of New York, Treasurer and Secretary. The Executive Committee consists of the Chairman and Secretary, and A. P. Joseph, electrical engineer, department head of the Westinghouse Company of Pittsburgh; B. M. Halpern, electrical engineer, Newark, N. J.; Emanuel N. Mohl, Brooklyn, N. Y., and B. H. Hirschenson, mechanical engineer of the Bureau of Standards, Washington. The engineers will establish a bureau of information and offices at 44 East Twenty-third Street, New York City.

President Nominates Men for Navy Engineer Corps

Existing Vacancies Filled from List of Successful Candidates at Recent Examination

President Wilson has sent to the Senate 25 nominations to fill existing vacancies in the grade of assistant civil engineer, Corps of Civil Engineers, United States Navy.

The nominees were the successful candidates in the final examination held recently in Washington, open to the 190 candidates who had passed the preliminary examinations and who represented 47 colleges and 29 states. Of this number, 62 candidates passed the preliminary examination and 53 presented themselves for the final examination, of whom 16 failed to qualify physically. Thirty-seven took the written examination, and out of this number 25 qualified and have been nominated for appointment as assistant civil engineers, with the rank of lieutenant (junior grade). The 25 men nominated represent 14 colleges and come from 9 states.

The examination was open to men under 26 years of age who had received an engineering degree from a college or university of recognized standing and who had had no less than 18 months' practical professional experience since graduation. The nominees are:

Name	Legal Residence	College or University
Cuthbert P. Conrad	Wisconsin	University of Wisconsin
Roy E. McCorkindale	Massachusetts	Rensselaer Polytechnic Institute
Ben Moreel	Missouri	Washington University
Robert L. Pettigrew	Wisconsin	Montana State College
Carl A. Trexel	Iowa	State University of Iowa
Kendal B. Bragg	Ohio	University of Wisconsin
Thomas J. Shack	New York	Massachusetts Institute of Technology
Alden K. Fogg	Illinois	University of Illinois
Arthur F. Peaslee	Massachusetts	Massachusetts Institute of Technology
Robert E. Thomas	Illinois	University of Illinois
Edward C. Seibert	Maryland	Lehigh University
Walter N. Moore	Missouri	University of Kansas
George W. Plaisted	Massachusetts	Worcester Polytechnic Institute
Arthur H. Bond	Massachusetts	Massachusetts Institute of Technology
Joseph J. Strachan	New York	Massachusetts Institute of Technology
Hector C. Griswold	New York	Rensselaer Polytechnic Institute
William H. Smith	Massachusetts	Massachusetts Institute of Technology
Henry G. Lehrbach	New York	Cornell University
Thomas E. Dunham	New York	Rensselaer Polytechnic Institute
Henry Niemann	Massachusetts	Massachusetts Institute of Technology
James L. McDonald	New York	New York University
Robert S. Johnson	Iowa	Iowa State College
Edward L. Marshall	Massachusetts	Tufts College
Richard H. Gifford	Delaware	Lehigh University
George D. Wetsel	New York	Rensselaer Polytechnic Institute

Here Are the 16 Contractors Who Will Build the National Army Cantonments

Name of Firm	Location of Camp
Bates & Rogers Construction Co., Chicago	Rockford, Ill.
Thompson Starrett Co., N. Y.	Yaphank, L. I., N. Y.
Smith, Hauser & MacIsaac, N. Y.	Annapolis Junction, Md.
Rinehart & Dennis, Charlottesville, Va	Petersburg, Va.
F. T. Ley & Co., Springfield, Mass.	Ayer, Mass.
Erwin & Leighton, Phila.	Wrightstown, N. J.
Hardaway Contracting Co., Columbus, Ga.	Columbia, S. C.
Arthur Tufts, Atlanta, Ga.	Atlanta, Ga.
A. Bentley Sons Co., Toledo, Ohio	Chillicothe, Ohio.
Mason & Hanger, Lexington and Richmond, Ky.	Louisville, Ky.
Porter Bros., Portland, Ore.	Battle Creek, Mich.
Charles Weitz Sons, Des Moines, Ia.	Des Moines, Ia.
George A. Fuller Co., N. Y.	Fort Riley, Kan.
Stone & Webster, Boston	Fort Sam Houston, Tex.
Hurley & Mason, Tacoma, Wash.	American Lake, Wash.
James Stewart & Co., N. Y. and St. Louis	Little Rock, Ark.

Goethals Engages Five Former Associates As Aids

Orders for Ten Steel And Four Wooden Ships Given—Marine Engines Are Building

Washington, D. C., June 24—Since discharging his two assistants, Clark and Eustis, Gen. George W. Goethals has added to the staff of the Emergency Fleet Corporation many of his former engineering associates on the Panama canal. Admiral H. H. Rousseau, who was engineer of terminal construction at Panama, was taken from the Bureau of Yards and Docks, where he was serving on the committee locating naval and coaling stations, to become his direct assistant. Major R. E. Wood, who served in Panama as chief quartermaster; F. A. Brown, who was chief inspector of materials; A. L. Bell, formerly mechanical engineer; W. R. McCann, former assistant electrical engineer, are all occupying similar positions in the Emergency Fleet Corporation.

Contracts for ten complete steel merchant ships; four complete wooden merchant vessels, and twenty wood ship hulls were announced June 25 by Major General Goethals, General Manager of the Emergency Fleet Corporation. Deliveries will be made in 1918.

The steel ships will be built by the Moore and Scott Iron Works at Oakland, Calif.; the complete wooden ships, by the Newcomb Lifeboat Company, Hampton, Va.; twelve wooden hulls by the Universal Shipbuilding Company, Harris County, Texas; four hulls by the Portland Ship Ceiling Company, Portland, Me., and four hulls by McBride & Law of Beaumont, Texas.

In addition to the ship contracts, orders for twelve vertical triple expansion marine engines were given to the Ellicott Machine Corporation of Baltimore.

In all, the Fleet Corporation has let contracts so far for 104 complete ships, 38 of steel; 32 of wood and steel, and 34 of wood. Seventy-two wooden hulls have also been ordered.

Hole Through Last of Lower East River Tunnels

Records for a Week's Progress Broken—a Lower Accident Rate Established

The last of the four east river tunnels under construction by New York City was completed on June 20 after making an unusual record for a low accident rate—only one fatality occurring in 800,000 individual decompressions. On one of these tunnels a progress of 95 ft. 4 in. was recorded for one week, comparing with a record of 88 ft. 10 in. for one of the other tunnels and with 82 ft. 6 in. made some years ago on one of the Pennsylvania R.R. tunnels. The best progress made in the tunnel for the old subway in one week was 67 ft. 10 in.

The final blast was fired by Oscar Strauss, chairman of the Public Service Commission, in the presence of D. L. Turner, chief engineer of the Commission, Robert Ridgway, chief engineer of subway construction, Clifford M. Holland, division engineer in charge of tunnel construction, several of the Public Service Commissioners, George H. Flinn and Major John F. O'Rourke of Flinn O'Rourke Co., Inc., who constructed the tunnels. For the contractor, the work in the four tunnels has been in charge of M. J. Quinn, general superintendent.

Government Places Large Order for Lumber Requirements

The Government has chosen the Southern Pine Emergency Bureau, mention of the formation of which was made in the issue of June 21, to furnish nearly 100,000,000 ft. of lumber for army cantonments and shipbuilding. The cantonment requirements are 78,000,000 ft. for use at the Louisville, Fort Riley, Little Rock, San Antonio and Chillicothe sites. For ships, 17,500,000 was asked, for eight of the fourteen vessels into which it will go are to be built near here.

Navy Department Busy on Camp Construction

Secretary Daniels Announces Locations at Which Building Are Under Way or Contemplated

Naval training camps at Philadelphia and Charleston, S. C., at each of which 5000 men can be accommodated, and Pensacola, Fla., at which 1000 additional men can be taken care of, have been completed, according to an announcement issued this week by Secretary Daniels. Seven other camps on the Atlantic coast, three on the Pacific coast, and one at Chicago, are nearing completion and a majority of them will be ready for occupancy about July 1.

The seven additional Atlantic coast camps are located as follows: Newport, R. I.; Cape May, N. J.; Key West, Fla.; Hingham, Mass.; Port Royal, S. C.; Quantico, Va.; and New Orleans, La. Others, it is understood, will be built at Gulfport, Miss., and Boston.

Pacific coast camps will include those at Mare Island, Calif.; Puget Sound, Wash.; and San Diego, Calif.

The selection of the sites for these camps has been under the direction of Rear Admiral Palmer, chief of the bureau of navigation, and the work of construction has been conducted under the supervision of Rear Admiral Harris, chief of the bureau of yards and docks.

These new camps, when completed, will provide accommodations for approximately 80,000 men at a cost of $9,000,000.

Washington Counties Issue Bonds for Irrigation Additions

On Saturday, June 16, property owners in Benton and Yakima counties, Washington, under the Horse Heaven Irrigation District, voted $18,000,000 in bonds to complete the project. About 215,000 acres can be watered for $45 per acre or 300,000 acres including reservoirs, at $87 per acre. The first meeting of an advisory committee chosen at the election, will be held with the present board on July 3, at which time the rights of the Klickitat Irrigation & Power Company, the Northwestern Electric Company and Yearsley Interests along the Klickitat River will be purchased.

The engineers on the work are: R. H. Thomson, Alaska Bldg., Seattle; O. Laurgaard, Railway Exchange Bldg., Portland, and A. J. Wiley, Butte, Mont. Attorneys for the district are: Farrell, Kane & Stratton, American Bank Bldg., Seattle; McGregor & Fristoe, of Portland, Ore., and R. B. Williamson, of North Yakima, Wash. Some of the items of construction are as follows: 150 miles of main canal, $8,000,000; two power and pumping plants, $500,000; six laterals, $1,979,000. Apparently the $18,000,000 bond issue does not cover the cost of constructing seven reservoirs, originally contemplated under a $24,000,000 bond issue, as these structures were to cost $8,833,000.

Construction Record Made On Frisco Cantonment

Regular Army Camp Built by 600 Carpenters at Rate of 15 Buildings per Day

By the careful organization of every phase of the work, the building of the cantonment at the Presidio in San Francisco has been carried out in what is believed to be record time for this kind of work. Practically all the lumber companies of the city were represented in an emergency committee which succeeded in delivering 2,500,000 ft. b.m. of lumber in just the order desired within 84 working hours. This organization was paralleled by that of the contractor in marshaling the army of about 600 carpenters and helpers who constructed the 210 buildings complete within 18 working days.

Speed—15 Buildings per Day

During the period of maximum activity the speed was 15 buildings per day, or a new building every 33 minutes. The buildings are roofed with patent roofing and equipped with terra cotta chimneys incased in galvanized iron tops. The construction referred to includes the hanging of doors and windows and the electric wiring but does not include the plumbing in lavatories, which was sublet in separate contract.

The general layout of the camp consists of four parallel rows of buildings with a main street in the center and two streets on the outside. The mess and bunk houses are 20 ft. wide and from 95 to 120 ft. in length. The contract was held by G. M. Gest, of San Francisco, for whom Harrison S. Taft was construction manager.

Cleveland Engineering Society Gets 22,000 Volumes

At the annual meeting of the Cleveland Engineering Society, held June 15, the retiring president, F. W. Ballard, made announcement that the American Society of Civil Engineers had given in trust to the Cleveland Engineering Society through the local association of the members of the American Society of Civil Engineers, all of the books of its library duplicated by books in the United Engineering Society's library, amounting to about 22,000 volumes. The donation is the result of the efforts of G. H. Tinker, librarian of the Cleveland Society, and of Wilber J. Wharton, president of the Cleveland Association of the American Society of Civil Engineers.

At the same meeting honorary membership was conferred upon Ambrose Swasey and S. G. Wellman, both past presidents of the Cleveland Society. The occasion was the 37th annual meeting of the Society and the attendance was about 300. J. H. Herron, whose biography appears on a succeeding page, was inaugurated as president for the coming year.

Contract Let for New Flying Field in Illinois

The Signal Corps announced on June 22 the letting of the contract for the fourth of the new Government flying fields, to be built at Belleville, Ill., 23 miles from East St. Louis. It will be a standard two-squadron field, accommodating 300 student fliers, with the requisite number of officer instructors, mechanics, and enlisted men, and providing hangars for 72 training planes. Construction of the buildings and the preparation of the field will begin immediately.

The locations of the fields already announced are Dayton, Ohio; Mount Clemens, near Detroit, Mich.; and Rantoul, near Champaign, Ill. The Government's present plans contemplate letting the fifth contract in about two weeks and the remaining four of the nine fields already authorized at successive intervals of two weeks thereafter.

The preparation of the three fields already started has been made an emergency job, and the Chanute Field, at Rantoul, Ill., is already nearly half done. The contract for Chanute Field was let on May 24 and work began on May 27. Substantial progress has also been made on the big four-squadron Wilbur Wright Field at Dayton and the Selfridge Field at Mount Clemens, Detroit. The authorities hope to have men flying on all three of these fields by the middle of the summer.

Cuban Construction Active, Says Commerce Expert

New sugar mills, railway construction, port improvements and hotel building in Cuba, as a result of the large crop and high prices of sugar, will soon make that island an excellent market for American construction machinery and materials, according to Special Agent W. W. Ewing, of the Bureau of Foreign and Domestic Commerce.

A number of new sugar mills are projected for this season, and considerable railway construction and extension are being planned. The prosperity brought to the island by the unusual sugar crop will result, according to Mr. Ewing, in much heavier general traffic, which will require additional wharf and warehouse space. Sites have been acquired, and plans are being prepared for modern hotel buildings at a number of points to meet the demands of tourist travel. Many other indications of engineering activity are to be seen in all parts of the island.

The United States is in the best position to supply the materials needed for such improvements, according to Mr. Ewing's report, which is entitled "Markets for Construction Materials and Machinery in Cuba," special agents series No. 139, and which may be obtained in the usual way at any of the offices of the bureau or from the superintendent of documents at Washington.

National Guard Engineers Ordered Into Service

Companies from Fifteen States Will Do Preliminary Work on Cantonments

Orders have gone to the governors of 15 states to muster into the Federal service 16 companies of engineers of the National Guard, who will be assigned to do the preliminary engineering work on the 16 sites for cantonments for the National Army.

One company each has been ordered from Massachusetts, New York, Pennsylvania, South Carolina, Georgia, Ohio, Indiana, Michigan, Illinois, Mississippi, Iowa, Kansas, Texas, and California, and two companies from New Jersey.

These are the first companies of engineers to be called into service since the beginning of the war. The present work of each company will be to plot out the site chosen for the cantonment, to prepare preliminary plans showing the contractor where sewers, water pipes, roads, regimental camps, and all necessary buildings and other works are to be placed.

Second Engineer Regiment To Be Recruited to 1141 Men

Col. Curtis McD. Townsend, Commander of the Second Engineers' Reserve Regiment, being recruited in St. Louis, today received instructions from the War Department to raise the strength of the regiment 10 per cent., or 103 men, to make the total roster 1141 men. Colonel Townsend has 935 enlisted. He expects to take the men into camp at Waterworks Park this week.

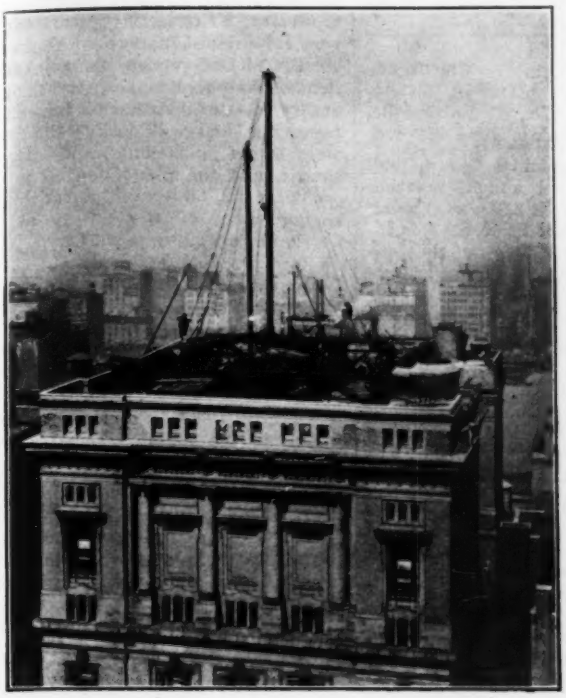
Harrison Shows Railroads Are Handling Heavier Tonnage

That real headway is being made in the effort to save the time of freight cars by quick and prompt loading and unloading is brought out in the figures given out by Fairfax Harrison, president of the Southern Ry. and chairman of the railroads' war board, which show that the daily average of cars loaded with bituminous coal each working day in May of this year was 28,449, an increase of 23.8 per cent. over May, 1916, and of 8.1 per cent. over April, 1917.

According to the Government figures now compiled, the 62 principal bituminous-coal-carrying railroads in May, 1917, hauled 142,157 more carloads of coal—approximately 7,100,000 tons—than they did in May, 1916. This was an increase of 23.8 per cent. The railroads hauled 739,674 carloads of bituminous coal in May of this year, compared with 597,517 cars in May, 1916.

In the month of May, while this greatly increased tonnage of bituminous coal was being handled, the railroads reduced the so-called car shortage from 148,627 on May 1 to 105,127 cars, almost one-third.

Engineering Societies Building Nearly Completed



The structural work of adding three stories to the Engineering Societies Building on 39th St., New York City, to provide necessary space for the American Society of Civil Engineers, is nearly completed and it is hoped that the new space can be occupied in the early fall. The work consists in building four new columns through the old frame and carrying the new stories on heavy trusses spanning the columns. As shown in the right-hand view, the addition has a tower effect, common to some of the newer types of New York skyscrapers, and fits in very well with the architectural design of the old building. The architect is H. G. Morse; the structural engineers, Purdy & Henderson, and the contractor, the Wells Construction Company.

Forestry Regiment Recruiting Now Under Way

As announced in the issue of May 24, p. 427, a forestry regiment will accompany the corps of engineers to France to help in the economical use of French timber. Recruiting for this unit is now under way and men wishing to enlist in this branch of the service should apply to the nearest of the following listing offices:

F. H. Colby, forest commissioner, Augusta, Maine; J. S. Benedict, United States Forest Service, Gorham, N. H.; E. C. Hirst, state forester, Concord, N. H.; Harris A. Reynolds, 4 Joy St., Boston, Mass.; W. O. Filley, state forester, New Haven, Conn.; C. R. Pettis, superintendent of state forests, Albany, N. Y.; J. S. Illick, Pennsylvania Department of Forestry, State Forest Academy, Mount Alto, Penn.; F. W. Besley, state forester, Johns Hopkins University, Baltimore, Md.; H. L. Johnson, United States Forest Service, Elkins, W. Va.; S. H. Marsh, United States Forest Service, Harrisonburg, Va.; Verne Rhoades, United States Forest Service, Asheville, N. C.; H. G. Spahr, United States Forest Service, Blue Ridge, Ga.; E. P. Bushnell, United States Forest Service, Johnson City, Tenn.; Edmund Secrest, state forester, Wooster, Ohio; T. B. Wyman, Munising, Mich.; W. T. Cox, state forester, St. Paul, Minn.; G. E. Marshall, United States Forest Service, Cass Lake, Minn.; F. B. Moody, conservation commissioner, Madison, Wis.; J. H. Foster, state forester, College Station, Tex.; the Forester, United States Forest Service, Washington, D. C.; district forester, United States Forest Service, Federal Building, Missoula, Mont.; district forester, United States Forest Service, New Federal Building, Denver, Colo.; district forester, United States Forest Service, Gas and Electric Building, Albuquerque, N. M.; district forester, United States Forest Service, Forest Service Building, Ogden, Utah; district forester, United States Forest Service, 114 Sansome St., San Francisco, Calif.; district forester, United States Forest Service, Beck Building, Portland, Oregon.

The listing of applicants by the foregoing officers does not insure their final acceptance, but is necessarily the preliminary step to be taken.

Engineers on Cantonment Construction Are Named

Will Have Title of Constructing Quartermaster—Many Are Chosen from Civil Life

Actual construction work at each of the 16 cantonments to be erected for the new National Army will be in charge of an officer of the Quartermaster Corps, either Regular or Reserve, to be known as the constructing quartermaster.

Under him will be an assistant quartermaster.

The constructing quartermaster will be in full charge at each cantonment, directing the laying out of the buildings and supervising for the Government the entire work of construction as carried on by the contractor.

The personnel of the constructing quartermasters includes a number of well-known civilian engineers who have been given major's commissions in the Quartermasters' Reserves Corps. In addition several officers of the Regular Army Quartermasters' Corps are acting in executive capacity.

Men Appointed from Civil Life

Among the men appointed from civil life are: Maj. O'Kelly Williams Myers, an engineer of the New York water department, who will be in charge at Yaphank, L. I.; Maj. Ralph Fenne Proctor, chief engineer of a Baltimore bonding company, who has been assigned to the cantonment at Annapolis Junction, Md.; Maj. William Couper, an engineer for the Pennsylvania R.R., who will be at Columbia, S. C.; Maj. James Norman Pease, principal assistant engineer of the Lockwood-Green Construction Co., of Columbus, Ga., who will be at the head of operations at Atlanta; Maj. Frank Elmer Lamphere, assistant engineer of the Baltimore & Ohio Co. at Chicago, assigned to Louisville, Ky.; Maj. Earle Bell Morden, a St. Paul railroad engineer, who will be at Battle Creek, Mich.; Maj. Donald Hubbard Sawyer, of Spokane, Wash., to be in charge at Rockford, Ill.; Maj. John R. Fordyce, a civil engineer of Little Rock, Ark., who will supervise the construction of the cantonment in that city; Maj. Millard Angle Butler, a St. Paul railroad engineer, to be in charge at Des Moines.

Regular Army officers named as constructing quartermasters are: Capt. Edward Canfield, Jr., Ayer, Mass.; Maj. Harry C. Williams, Wrightstown, N. J.; Capt. Frank B. Edwards, Petersburg, Va.; Capt. Ward Dabney, Chillicothe, Ohio; Capt. Frank J. Horman, Fort Riley, Kan.; Capt. George E. Thorne, Fort Sam Houston, Tex.; and Capt. David L. Stone, American Lake, Wash.

The following officers have been named as assistant quartermasters: Capt. Graham Parker, Annapolis Junction; Capt. Thomas W. Holliday, Columbia, S. C.; Capt. Mark L. Ireland, Louisville; Capt. Manuel N. Garrett, Battle Creek; Capt. Owen G. Collins, Rockford; Capt. Joseph C. Kay, Des Moines.

Engineering Societies

The Brooklyn Engineers Club made an excursion to the plant of the Atlantic Terra Cotta Co., at Tottenville, Staten Island, Saturday, June 23.

The National Municipal League will hold its twenty-third annual meeting in Detroit, Mich., Nov. 21 to 24, having headquarters at Hotel Statler. For information concerning this meeting address the secretary, Clinton Rogers Woodruff, 703 North American Building, Philadelphia.

The Steel Treating Research Club of America, having had its offer of service to the Government accepted, desires that its members communicate with headquarters in Detroit, stating the exact character of work which they are best qualified to take charge of.

The Pacific Northwest Society of Engineers met June 16 in the Chamber of Commerce, Seattle, to hear a paper by H. E. Fowler, assistant superintendent of buildings, Seattle, on "Tests of Flat Slabs in American Can Co.'s Building." Charles V. E. Dove read a paper on "An Automatic Stoker."

Engineering Schools

The University of Wisconsin announces that the nineteenth annual summer session of the College of Engineering will be held at Madison during the six weeks' period beginning June 25, 1917. Special courses will be given in chemistry, electrical, steam and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shop work and surveying. All courses given in the summer session are open to engineering students. Special courses have been arranged for enginering, manual arts and vocational teachers.

The Massachusetts Institute of Technology has started nine special courses of study for military or naval purposes, as follows: Early work on internal-combustion engines; an intensive course in naval architecture; the "cram" courses for students wishing to take army engineering examinations; special aëronautical courses; special 12 weeks' summer military camp at Camp Cunningham; courses for first-officer examination, a school which is being conducted by Technology in different places on the coast for the convenience of local groups of seamen; special junior military school in the Tech Building in Cambridge; and special courses for naval-officer examinations.

The College of the City of New York announces a course of 15 two-hour lectures and seven field series especially planned for the members of those military units in which a knowledge of map making, topographic sketching, use of surveying and mapping instruments is necessary. The lectures will cover in very close detail the various methods of horizontal and vertical control, estimations of distances, slopes, elevations and grades, uses of instruments for military surveying, and will outline the fundamentals of sketching and traverse boards, and the planetable. The field problems will be worked out at the surveying camp of the college at Van Cortland Park, New York City.

Personal Notes

Mark G. Cohn, who has been chief deputy in the Building Department of Los Angeles, Calif., has accepted the position of director of the California State Housing and Immigration Commission.

Thomas Maddock has been appointed to the office of state engineer of Arizona.

J. R. McDermott, who acted as road inspector in Trumbull County, Ohio, is now field inspector with the Portland Cement Association, with headquarters at Pittsburgh.

John W. Bulger is now connected with the county engineering office of Coshocton County, Ohio, of which **A. H. Shaw** is in charge.

Erich A. Mees, for more than five years engineer and superintendent of construction with Tucker & Laxton, Inc., contracting engineers, Charlotte, N. C., has resigned his position with the above firm to enter into a partnership with his brother, **Curtis A. Mees,** consulting engineer. Mr. Mees will have his office at 310 Trust Building, Charlotte.

R. E. Ezell, who has been with the Southern Ry. for the last 19 years, recently resigned as principal assistant civil engineer of that railway and retired from professional service.

Alex G. Hoffman, formerly with the valuation department of the Pennsylvania R.R., is at present with the Schuylkill Bridge Works at Pottstown, Pennsylvania.

S. B. Newman and **M. F. Cavallon,** both of whom were formerly connected with the Masters Builders Co., have formed a new partnership under the name of the Newman-Cavallon Co., with offices at 8 West 40th St., New York City. The products of this concern will be similar in general character to those which both Mr. Newman and Mr. Cavallon have been handling for the last several years.

Samuel Insull, president, Commonwealth Edison Co., Chicago, was given the degree of doctor of science, honoris

causa, at the one hundred and twenty-fifth commencement exercises of Union College, Schenectady.

Robert **L. Fox**, formerly city engineer of Batavia, N. Y., has accepted a position as assistant engineer on the construction of the sanitary sewer system at Johnstown, Pennsylvania.

Will **Rights**, of Purdue University, has been selected assistant engineer to the State Highway Commission of Indiana and will act as secretary to the commission until the state engineer is appointed.

S. T. Cantrell, superintendent, Baltimore & Ohio R.R., with headquarters at Philadelphia, has been granted a leave of absence during his time of service with the Government on railroad work in Russia. **R. B. White**, superintendent, Seymour, Ind., will be transferred to Philadelphia.

W. I. Risley has been granted a six months' leave of absence from his duties as city engineer of Ventnor City, N. J., to receive training with the Engineer Officers' Reserve Corps. **Eugene Somers**, who prior to 1912 was principal assistant to the county engineer, Atlantic County, N. J., and for the past two years assistant engineer in the Engineering Department of Woonsocket, R. I., has been designated acting city engineer for the period of Mr. Risley's absence.

E. C. Koppen, formerly on the Carlsbad project at Carlsbad, N. M., has been appointed assistant engineer, United States Reclamation Service, with headquarters at Klamath Falls, Oregon.

M. H. Montross is at present with the New York State Conservation Commission, under **Alex Wright McKim**, inspector of docks and dams, with headquarters in Buffalo.

M. H. Doyne, who has been in charge of extensive railroad surveys of East St. Louis and vicinity, has been sent to Oklahoma City as resident engineer for C. E. Smith, consulting engineer, St. Louis, in charge of the construction of the Oklahoma Belt Ry. At one time Mr. Doyne was connected with the Public Service Commission of New York on the designs of the subway system of that city.

E. H. Jones, who for the past three years has been located in California in private practice, and as junior engineer with the Los Angeles County Flood Control District, has returned to Colorado and is now in his former position as district engineer for the North Sterling Irrigation District, Sterling, Colorado.

George C. Kenney has resigned as president of the Beaver Contracting and Engineering Corporation, Boston, Mass., to enter the army. **Paul C. Ordway**, secretary of the same company, has likewise resigned to enter the navy. **L. Gordon Glazier** becomes president and treasurer. The offices of the company have been removed from State St. to 57 Cummings Road.

Horace B. Olmsted has been appointed superintendent of highways and bridges in the town of Darien, Conn., having been previously assistant engineer for the Connecticut State Highway Commission with headquarters at New Haven.

Major P. W. Davidson, disbursing officer of the Alaska Railroad Commission and inspector in chief of the National Guard of Alaska, recently transferred the headquarters of the Alaska Railroad Commission to Juneau, from Valdez, Alaska.

Marvin Chase was recently appointed hydraulic engineer for the State of Washington. This position was created by the Water Code passed at the last session of the state legislature. Mr. Chase has been for 30 years a hydraulic engineer, and for the past 25 years has been connected with irrigation projects. In 1901 he superintended the old Sunnyside canal, then owned by the Washington Irrigation Co. He resigned that year and associated himself with W. T. Clarke in enlarging the old Selah canal, later going to Billings, Mont., to install an irrigation canal. Mr. Chase is a past president of the Pacific Northwest Society of Engineers.

O. E. Eltinge, chief draftsman, sewer division, Kansas City department of engineering, has been granted a three months' leave of absence to accept a temporary position as second in charge of laying out training camps at Fort Riley, Kan., under Maj. H. H. Roberts, Corps of Engineers, U. S. Army.

Edmund B. Ulrich has been reëlected city engineer of the City of Reading, Pennsylvania.

C. R. Kulp, division engineer on the Chicago & North Western, at Antigo, Wis., has been appointed trainmaster at Benld, Ill., succeeding **F. R. Lloyd.**

E. J. Correll, district engineer maintenance-of-way of the southwestern district of the Baltimore & Ohio, with headquarters at Cincinnati, Ohio, and formerly division engineer of the Illinois division, has been appointed superintendent of the Delphos division of the Cincinnati, Hamilton & Dayton, with headquarters at Dayton, Ohio, succeeding **R. B. Mann.**

E. H. May, assistant division engineer of the Pennsylvania Lines, at Logansport, Ind., has been transferred to Fort Wayne, Ind., to succeed **H. T. Sympson.**

Christopher Johnson has been appointed city engineer of Warrensburg, Missouri.

Col. Samuel E. Tillman, who was retired in October, 1911, while serving as a professor at the United States Military Academy, has been recalled to active service and assigned to duty as superintendent of the Military Academy, relieving **Col. John Biddle**, Corps of Engineers, who has been placed temporarily in command of the 6th Regiment of Engineers. Colonel Tillman was graduated from the Military Academy in 1869, and served three years in the artillery and eight years in the engineers. In December, 1880, he was appointed an instructor at the academy and served in that capacity until his retirement in 1911.

F. S. Small is at present in charge of the revision of the original plans for the hydro-electric development at Cedars, Quebec, for Fraser, Brase & Co. Mr. Small was for 3½ years superintendent of construction for the Mond Nickel Co., Coniston, Ont., and then acting district engineer, in charge of the St. John River District, for the Canadian Department of Public Works.

J. M. Trevor, manager of the mixer department of the Chain Belt Co., Milwaukee, has been appointed New York manager of the company, representing the Rex line of concrete mixers. His office is at 30 Church Street.

A. W. Schorger, who for seven years has been connected with the Forest Products Laboratory, has resigned to take charge of organic chemistry with the C. F. Burgess Laboratories, at Madison, Wisconsin.

Arthur H. Blanchard, professor of highway engineering, at Columbia University, New York, has been retained as consulting engineer on the highway work of the New York City Board of Water Supply.

W. G. Mackendrick, president of the Warren Bituminous Paving Co., of Toronto, Ont., has been in France for the past two years building roads at the front. He was first captain in the Canadian Corps of Engineers and later a deputy assistant director of roads with charge of all roads in connection with the operation of the Fifth British Army in France, as major. He has recently been given the rank of lieutenant colonel with the same duties as before. Mr. Mackendrick has been in the business of road construction since 1890, when he was connected with the Warren-Scharf Asphalt Paving Company.

Prof. Arthur D. Winslow, head of the civil-engineering department at Norwich University, has recently been appointed city engineer of Montpelier, Vt. Professor Winslow has held positions with the Pennsylvania R.R., with the New York Board of Water-Supply on the Catskill project, and was for one year assistant engineer of the City of Everett, Massachusetts.

C. C. Cottrell, formerly connected with the California Highway Commission, has accepted a position as assistant highway engineer of Nevada and is

taking up headquarters in that state with Chief Engineer R. K. West, whose appointment was noted in these columns on June 7.

Harold G. McGee, sanitary engineer, Jackson, Mich., has resigned to become principal assistant to **L. A. Boulay**, Lucas County sanitary engineer, Toledo, Ohio. Previous to his engagement at Jackson, Mr. McGee was assistant engineer with the Ohio State Board of Health.

Theodore Tobish has been appointed engineer for Hamilton Township, Mercer County, N. J., and will serve as technical director for the extensive public improvements to be made there.

Harrington & Peters Co., general contractors, Seattle, Wash., have recently filed notice of dissolution of partnership. The firm was composed of **P. A. Harrington** and **E. G. Peters.** Each will continue in the contracting business under his own name, occupying separate offices in the Oriental Building, Seattle.

R. D. Goodrich, formerly manager of public utilities at Ypsilanti, Mich., has recently been appointed city engineer of Lansing, Mich. Mr. Goodrich has had about 15 years' experience in municipal and hydraulic work, being five years city engineer of Cheyenne, Wyo., during which time he designed and built a filter plant for that city and Fort D. A. Russell.

Arthur M. Torrey, formerly with W. B. Barstow & Co., Inc., has left that organization to reënter the employ of Hildreth & Co., inspection engineers, New York City, with which firm he was connected for several years prior to joining the Barstow company.

K. O. Truell, formerly connected with the Buffalo Potash and Cement Corporation as field engineer on construction, is now mechanical engineer on research at Niagara Falls for the Aluminum Co. of America.

O. L. Lockwood, formerly assistant engineer in the construction department of the Southern Ry., is now in charge of engineering and development work in connection with new coal mines being opened at Parish, Ala., for the exclusive use of the Southern Railway Company.

A. W. D. Hall, city engineer, Jackson, Mich., has been made city manager, succeeding **Gaylord Cummin**, who resigned to become city manager of Grand Rapids, as noted in these columns May 3.

Lawford Grant has been promoted to the position of managing director and treasurer of the Eugene F. Phillips Electrical Works, Ltd., Montreal, succeeding **George H. Olney**, who has been the head of that firm for 18 years. Mr. Grant was formerly engineer for the British Insulated & Helsby Cables, Ltd., of England. Among the undertakings carried out for this latter company by Mr. Grant was the electrification of the Government dock yard and naval base at Malta.

J. L. Jacobs, while still continuing in his position of southern manager for James Stewart & Co., Inc., has just moved his headquarters to Newport News, Va., to take care of plant extensions for the Newport News Shipbuilding and Dry Dock Co., in connection with its contract with the Government for two battle cruisers and two battleships. The work involves the construction of two new sets of ways and an office building.

C. H. Deaton, formerly chief engineer of the Yukon-Pocahontas Coal Co., is now in a similar position with the Leckie Collieries Co., Aflex, Ky., having charge of those things which pertain to the welfare of the employees of the company. This is a new departure and a tendency toward bettering the condition for the miner and improving the understanding between the operator and the employee.

R. E. Boyce has returned to Camden, N. J., as resident engineer of sewer construction on work which was not completed last fall due to labor shortage.

Walter L. Watson, formerly resident engineer for J. F. Witmer Co., at Ironton, Ohio, is superintendent for the Gaylord Construction and Engineering Co., Scranton, Penn., in the installation of a water system and reservoir for Indianapolis.

J. G. Kaulfuss, at various times with the Wisconsin State Highway Commission, the Highway Commission of Maine, instructor in engineering at the University of Maine and connected for a short time with the Office of Public Roads, has been appointed field man and publicity agent for the North Dakota State Highway Commission.

Obituary

James M. Courtright, who was prominently identified with the building of the Canada Southern Ry., died recently at his home in Inwood.

James Warren, who was civil engineer and land surveyor for the County of Halton and the County of Bruce, died recently at Walkerton, Ont. For over 30 years Mr. Warren was in the employ of the Dominion Government on survey work.

George A. Stewart, for many years chief engineer of the Midland Ry., who built many of the largest bridges on that system, died recently at Victoria, British Columbia.

James Mason Crafts, president of the Massachusetts Institute of Technology from 1898 to 1900, died June 19 in Ridgefield, Conn. Having served two years as professor of chemistry at Cornell, Mr. Crafts became head of the department of chemistry at the Institute and was identified with it as a leader in research work in this country and abroad.

Charles S. Hall, engineer of track elevations, Chicago & Northwestern Ry., died June 15 at the age of 60. Mr. Hall graduated from the Iowa State University and had served 28 years in the engineering department of the Northwestern Ry. and 6 years with the Great Western Railway.

Sir Alexander Richardson Binnie died May 18, at Beer, Devon, England, at the age of 78 years. Sir Alexander received his early education in the private schools and then served a regular term of pupilage under Terence Wolfe Flannagan and John Frederic LaTrobe Bateman. From 1862 to 1866 he was engaged in various works for the Welsh railways; for part of this time acting as assistant engineer on the Mid-Wales Lines under John Watson and Richard Smallman, and was also employed on the Neath & Breton Ry. under J. G. McKenzie, and on the extension of the Pembroke & Tenby Ry. under John Mathias. Having practiced for a few years as a consulting engineer, in January, 1868, he was appointed to the Public Works Department and proceeded to India as executive engineer in railway service and in the preparation of projects for the supply of water to several stations. In 1871 he was made assistant to the chief engineer. Returning to England in 1875, he held the position of water engineer at Bradford for 15 years. In 1890 he became chief engineer to the London County Council, which position he held down to 1901. During this period he made an investigation and reported on the project of supplying London with water drawn from North Wales, comparing this supply with that taken from the River Thames. During this same period the sewage-disposal works at Barking and Crossness were completed and the Barking Road bridge over the River Lea was built. He was responsible also for the construction of the Blackwall vehicular tunnel under the River Thames. He was elected an associate member of the Institution of Civil Engineers in February, 1865, and a full member in May, 1873. He was president of the institution in 1905, and received on different occasions the Telford Medal, the George Stephenson Medal and the Telford Premium. He was also a member of the Institution of Mechanical Engineers.

Donald Grant, who for 12 years was a partner of Foley Brothers, railroad contractors, of St. Paul, died suddenly June 14. Mr. Grant was born in Glengarry, Canada, in 1837, and came to Minnesota in 1868 to engage in railroad-construction work on the Chicago, Milwaukee & St. Paul. He also built many miles of the Soo, Great Northern, Northern Pacific, Wisconsin Central, Minneapolis & St. Louis, and the Canadian Pacific.